Rožnovský, J., Litschmann, T. (ed): „Bioklimatologie současnosti a budoucnosti“, Křtiny 12. – 14.9.2005, ISBN 80-86 690–31-08

EFFECTS OF STAND TENDING ON THE INTERCEPTION OF ATMOSPHERIC PRECIPITATION

Klára Kamlerová

Souhrn

V tomto příspěvku je na příkladu výzkumné plochy Rájec hodnocen význam intercepčních ztrát v mladých smrkových porostech vrchovinné oblasti na stanovišti původně smíšených porostů. Množství a intenzita atmosférických a podkorunových srážek byla měřena v mladém, plně zapojeném, nevychovávaném smrkovém porostu na Drahanské vrchovině (stav před probírkou – hodnoceno na 14 případech z let 2002 a 2003). Stejná měření probíhala v tomto porostu také po provedení silného probírkového zásahu (stav po probírce – hodnoceno na 21 případech z let 2004 a 2005). Množství atmosférických srážek před probírkou (3,6 až 25,3 mm) a po probírce (3,5 a 22,2 mm) bylo srovnatelné. V obou variantách byl vztah mezi množstvím atmosférických a podkorunových srážek vyjádřen lineární rovnicí.

Při atmosférické srážce větší než 5 mm porost ve stavu po probírce zadržoval srážek méně (vyšší hodnoty podkorunových srážek oproti stavu před probírkou). Snížením hustoty porostu se výrazně zmenšila skropná plocha korunové biomasy - při srážkových úhrnech 5 mm a více vedlo snížení hustoty porostu k zvýšení množství podkorunových srážek. Intercepční schopnost mladých smrkový porostů je značná. V průměru sledovaný smrkový porost před probírkou zadržoval 50 % srážek (amplituda 37 %). Protože je intercepce silně závislá na množství korunové biomasy (zadržování srážek v porostech je úměrné hustotě koruny), je možno záměrnou redukcí hustoty porostu výchovnými zásahy intercepci porostu snížit a zvýšit tak přívod srážek k půdě. V tomto případě snížení hustoty porostu, vedlo ke snížení průměrné intercepce o 10 % (intercepce po probírce 40 % atmosférických srážek) při současném zvýšení amplitudy hodnot intercepčních ztrát (amplituda 46 %) a poklesu hodnot intercepce pro jednotlivé případy (intercepční ztráty se pohybovaly od 16,7 do 62,6 % atmosférických srážek oproti stavu před probírkou - 35,2 až 72,2 %). Množství porostních srážek se dočasně zvýšilo. Množství asimilační biomasy výrazně podmiňuje zadržování srážek na povrchu rostlin (intercepci).

Introduction

Stand tending is an important silvicultural measure which can affect the development of forest stands both from the viewpoint of wood-producing and non-wood-producing functions of forests. However, the influence of tending felling is markedly variable being dependent on site conditions, stand origin and its species, age and spatial structure.

The amount of assimilatory biomass conditions both the quantity of physiological evaporation (transpiration) and retention of precipitation on the surface of plants (interception). From the aspect of water balance particularly interception is important impoverishing an ecosystem for the part of atmospheric precipitation.

Interception under conditions of our country up to an altitude of 600 to 850 m is markedly a loss item in the precipitation budget. Very high interception show particularly artificially established spruce stands on allochthonous sites (Vinš et al. 1996). On the example of the research area Rájec the importance is assessed of interception losses in young spruce stands of an upland region on the site of originally mixed stands.

Material and methods

The research area occurs in the Drahanská vrchovina Upland (CR) about 3 km west of the village of Němčice. Its position is given by coordinates 49°26´ N, 16°41´ E and altitude about 620 m. According to the climatological classification of the CR climate, the research area is situated in the region MT7. Total precipitation in the growing season amounts to 400 to 450 mm, in the winter period 250 to 300 mm.

Ing. Klára Kamlerová, Ph.D., kk@mendelu.cz, Ústav ekologie lesa, Mendelova zemědělská a lesnická univerzita v Brně, Zemědělská 3, 613 00 Brno, Česká republika.

Our attention was aimed at a closed untended plot (25 × 25 m) of a Norway spruce (*Picea abies* [L.] Karst.) stand established at a spacing of 2.5 x 2 m in 1978. Since the stand origin no tending measure was carried out there (see Janíček 1990, Knott 2002). Interception losses for this stand were assessed on the example of 2002 (for more details, see Kamlerová, Kučera 2003) and 2003. It the same plot, a heavy thinning measure was carried out in spring 2004 (see Knott, in print). The stand density decreased to about 1900 trees/ha after the measure (as against the situation before thinning – 2200 trees from planting/ha). Interception losses for this condition of the stand were evaluated on the example of years 2004 and 2005.

The amount and intensity of atmospheric precipitation and throughfall were measured using SR03 ombrometers with an intercepting area of 500 cm^2. Throughfall in this paper is understood as the sum of stand precipitation (precipitation coming through the tree crown contact) and infiltration of precipitation through stand gaps. A system for measuring throughfall was complemented by four two-meter polyethylene troughs arranged in the form of a cross of a total collecting area of 16 000 cm^2 situated at a height of 1 m above the soil surface in such a way to represent the stand variability (Kamlerová, Kučera 2003).

The amount of precipitation (atmospheric or throughfall) is the total amount of precipitation water fallen during one precipitation, ie the sum of all 10-minute amounts from the first record of atmospheric precipitation to the last record in the througfall rain gauge.

Interception was determined from the difference of atmospheric precipitation and throughfall in such a way that in the evaluation of interception losses only those cases were included when the amount of throughfall was ≥ 1 mm. In all cases, it refers to the interception of vertical precipitation without the interaction of horizontal precipitation. The stem flow is considered to be negligible and, therefore, it was not taken into account.

Results and discussion

Situation before thinning: The amount of atmospheric precipitation (Tab. 1) ranged between 3.6 and 25.3 mm in 2002 and 2003. With the increasing amount of the precipitation the amount of throughfall also increased, from 1.0 to 14.6 mm. In accordance with Chroust and Tesařová (1985), the relationship between the amount of atmospheric precipitation and throughfall (Fig. 1) was expressed by a linear equation $y = 0.5531 x - 0.3167$. Interception of falling precipitation on the surface of plants is linearly dependent on the amount of atmospheric precipitation ($R^2 = 0.9656$).

Interception losses ranged from 35.2 to 72.2% of atmospheric precipitation (Tab. 1) and on average, this spruce stand retained 50% precipitation. These values are higher than those for a mature closed spruce stand of mountain locations (Kantor, 1995). According to results of the author, interception losses reach 5.2 to 40.1% open area precipitation in particular months. Values of interception (22%) for closing spruce thickets (7 – 12 years) are also lower (Mrkva, 1991). On the other hand, the average value of interception found in our studies is in accordance with results of Chroust (1965). According to the author, spruce stands intercept on average 30 – 50% open area precipitation interception in closed stands being proportional to the density of crowns. The differences have to be assessed with respect to the various age and canopy of evaluated stands. It is also important that the majority of authors evaluates monthly totals whereas we use a finer measure – the amount of particular precipitation. Thus, the substance of the whole evaluation consists in observing the dependence of interception on the wetted area of crown biomass (the area of assimilatory organs) and taking the evaluated interval into account.

Ing. Klára Kamlerová, Ph.D., kk@mendelu.cz, Ústav ekologie lesa, Mendelova zemědělská a lesnická univerzita v Brně, Zemědělská 3, 613 00 Brno, Česká republika.

Tab. 1: The amount of atmospheric precipitation and throughfall in selected cases of 2002 and 2003.

Precipitation:		Amount (mm)		Interception	
Number	Start	Atm. precipitation	Througfall	mm	%
1	18.07.02	3.6	1.0	2.6	72.2
2	07.07.02	3.6	1.2	2.4	68.1
3	02.07.03	4.7	1.9	2.8	58.6
4	29.09.03	4.7	2.3	2.4	51.8
5	02.11.02	4.8	3.1	1.7	35.2
6	22.11.02	5.6	3.6	2.0	35.9
7	09.09.03	6.4	2.2	4.2	65.1
8	27.10.02	6.6	3.4	3.2	48.5
9	25.10.02	6.6	4.2	2.4	36.8
10	19.11.02	6.8	4.2	2.6	38.5
11	04.07.02	10.7	5.7	5.0	47.1
12	06.06.02	14.7	6.7	8.0	54.7
13	16.07.02	22.8	11.6	11.2	49.3
14	15.05.03	25.3	14.6	10.7	42.2

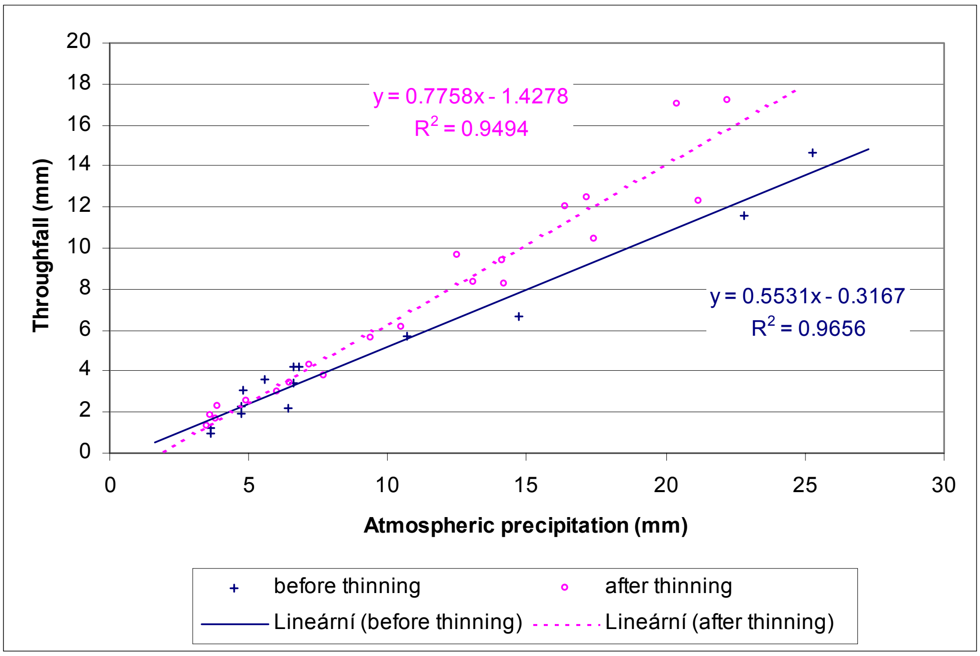

Fig. 1: Relationships between the amount of atmospheric precipitation and throughfall: 2002 and 2003 (before thinning) and 2004 and 2005 (after thinning).

Situation after thinning: In 2004 and 2005, the amount of atmospheric precipitation (Tab. 2) ranged between 3.5 and 22.2 mm, the amount of throughfall 1.3 to 17.2 mm and their interrelation (Fig. 1) was expressed by a linear equation y = 0.7758 x – 1.4278 (R^2 = 0.9494).

Interception losses ranged from 16.7 to 62.6 % atmospheric precipitation (Tab. 2) and on

Ing. Klára Kamlerová, Ph.D., kk@mendelu.cz, Ústav ekologie lesa, Mendelova zemědělská a lesnická univerzita v Brně, Zemědělská 3, 613 00 Brno, Česká republika.

average, the spruce stand intercepted 40.0% precipitation after a heavy thinning measure.

Conclusion

The amount and intensity of atmospheric precipitation and throughfall were measured in a young fully closed untended spruce stand in the Drahanská vrchovina Upland (situation before thinning – assessed in 14 cases of 2002 and 2003). The same measurement was also carried out in the stand after the accomplishment of a heavy thinning measure (in more details Knott- in press) – evaluated in 21 case of 2004 and 2005.

Tab. 2: The amount of atmospheric precipitation and throughfall in selected cases of 2004 and 2005.

Precipitation:		Amount (mm)		Interception	
Number	Start	Atm. precipitation	Througfall	mm	%
1	21.10.04	3.5	1.3	2.2	62.6
2	13.11.04	3.6	1.8	1.8	50.0
3	03.07.04	3.8	1.7	2.1	56.5
4	13.04.05	3.9	2.3	1.7	42.3
5	11.07.04	4.9	2.6	2.3	47.5
6	20.04.05	6.0	3.0	3.0	49.7
7	04.06.05	6.5	3.4	3.1	47.1
8	01.07.04	7.2	4.3	2.9	40.2
9	10.05.05	7.7	3.8	4.0	51.3
10	25.04.05	9.4	5.6	3.8	40.2
11	03.05.05	10.5	6.2	4.3	41.2
12	18.05.05	12.5	9.6	2.9	23.0
13	16.11.04	13.1	8.3	4.8	36.7
14	09.07.04	14.1	9.4	4.7	33.2
15	09.06.04	14.2	8.3	5.9	41.8
16	31.10.04	16.4	12.0	4.4	26.9
17	09.04.05	17.2	12.4	4.8	27.8
18	22.07.04	17.4	10.5	6.9	39.9
19	09.01.00	20.4	17.0	3.4	16.7
20	23.05.05	21.2	12.3	8.9	41.9
21	30.05.05	22.2	17.2	5.0	22.6

The amount of atmospheric precipitation before thinning (3.6 to 25.3 mm) and after thinning (3.5 to 22.2 mm) was comparable. In both cases, a relationship between the amount of atmospheric precipitation and throughfall was expressed by a linear equation. With decreasing stand density the value of parameters a and b of the linear equation increased. The spruce stand after thinning intercepted more precipitation (lower values of throughfall as against the situation before thinning) up to the value of atmospheric precipitation amounting to 5 mm. However, as mentioned by Chroust (1997) the highest variability occurs in low precipitation and moreover, the crown space is not homogeneous and thus, the penetration of precipitation to the stand interior is not uniform. The relationship (for total precipitation up to 5 mm) cannot be also demonstrated with respect to the low number of cases under evaluation.

In an atmospheric precipitation higher than 5 mm, the stand after thinning intercepted less precipitation (higher values of throughfall as against the situation before thinning). Through the decrease in stand density the wetted area

Ing. Klára Kamlerová, Ph.D., kk@mendelu.cz, Ústav ekologie lesa, Mendelova zemědělská a lesnická univerzita v Brně, Zemědělská 3, 613 00 Brno, Česká republika.

of crown biomass markedly decreased and in precipitation totals 5 mm and more the decrease in stand density resulted in the increase of the amount of throughfall.

The interception potential of young spruce stands is considerable. On average, the studied spruce stand before thinning intercepted 50% precipitation (amplitude 37%). Because interception is markedly dependent on the amount of crown biomass (interception in stands is proportional to the crown density) it is possible to decrease stand density by the intentional reduction of stand density through tending measures and thus to increase the input of precipitation to soil. In this case, decrease in stand density resulted in the decrease of average interception by 10% (interception after thinning 40% atmospheric precipitation) at the simultaneous increasing the amplitude of values of interception losses (amplitude 46%) and decrease in the value of interception for particular cases (interception losses ranged from 16.7 to 62.6% atmospheric precipitation as against a situation before thinning - 35.2 to 72.2%). The amount of stand precipitation temporarily increased. The amount of assimilatory biomass markedly conditions the interception of precipitation in the surface of plants.

Acknowledgement

This study was supported by the Grant Agency of the Czech Republic, Grant No. 526/01/D079.

References

Chroust, L., 1965: Porostní klima smrkových tyčkovin při výchově silnými zásahy. Lesnický časopis, 11: 1067-1088.

Chroust, L., 1997: Ekologie výchovy lesních porostů. Opočno, VÚLHM: 277pp.

Chroust, L., Tesařová, J., 1985: Intercepce v mladých borových porostech. Práce VÚLHM: 161-189.

Janíček, R., 1990: Analysis of the structure and the development of a spruce population in a reforested clearcut area (in Czech). Final report. Univ. Agric and For. Brno, 27 pp.

Kamlerová, K., Kučera, J., 2003: Intercepce mladého smrkového porostu. In: Hurtalová, T. et al. (eds.), 11th International Poster Day “Transport of Water, Chemicals and Energy in the System Soil-Crop Canopy-Atmosphere”. Bratislava 20.11.2003, IH-SAS / GPI-SAS. CD: 185-188.

Kantor, P., 1995: Vodní režim smrkových a bukových porostů jako podklad pro návrh druhové skladby vodohospodářsky významných středohorských lesů. Habilitační práce. Brno, MZLU v Brně: 332 pp.

Knott, R., 2002: Development of a young stand of Norway spruce (*Picea abies* [L.] Karst.] of the second generation on an allochthonous site. Ecology (Bratislava), 21, Supplement 1: 5-13.

Mrkva, R., 1991: Intercepční ztráty ve smrkových ekosystémech nižších vegetačních stupňů. Zpravodaj Beskydy, 4: 66-71.

Vinš, B. et al., 1996: Dopady možné změny klimatu na lesy v České republice. Národní klimatický program ČR. Praha, ČHMÚ, 19: 135 pp.

Ing. Klára Kamlerová, Ph.D., kk@mendelu.cz, Ústav ekologie lesa, Mendelova zemědělská a lesnická univerzita v Brně, Zemědělská 3, 613 00 Brno, Česká republika.