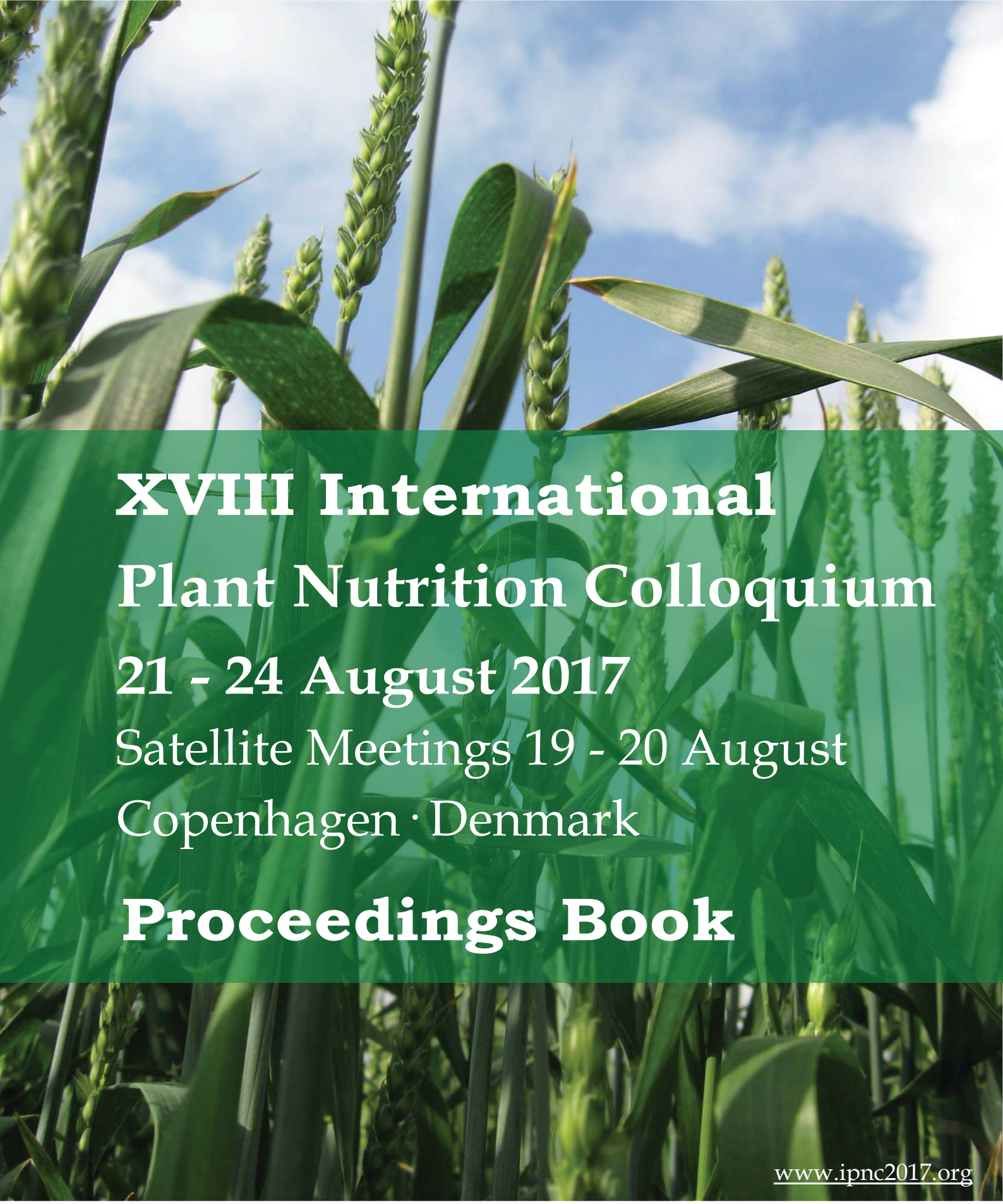

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Nutrient resorption in two co existing Nothofagus species in southern Patagonia

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INTRODUCTION

Nutrient resorption understood as the "movement" of nutrients from leaves prior to abscission towards other tissues or internal stores has been suggested to be a key component of nutrient conservation in deciduous forest species (Ares and Gleason 2007). This strategy allows plants to use these nutrients for new growth or store, hence decreasing their dependence on soil nutrient availability. Native forests in southern Argentine Patagonia cover approximately 1.2 million ha, corresponding more than 95% of these forests to the southern beeches *Nothofagus pumilio* (lenga) and *Nothofagus antarctica* (ñire) (Peri et al. 2016). In general, both deciduous species occupy places with different environmental conditions. *N. pumilio* forest are mostly found as pure stands in well-drained soils, while *N. antarctica*, a more plastic and rustic species, is displaced to more unfavourable site conditions including rocky or poorly drained soils, and more xeric zones in the limit with the Patagonian steppe. Nevertheless, there are small transitional areas where both species can co-exist using the same sources of resources. The objective of this study was to compare nutrient resorption of both species growing together in two contrasting situations of environmental conditions and forest productivity.

METHODS

Study sites

The study sites represent contrasting environmental conditions with altitude (A), mean annual precipitation (MAP) and mean annual temperature (MAT) as main variables, which resulted in different dominant height of mature trees (H) (as indicator of productivity). The higher productive site (HPS) had 233 m.a.s.l., 610 mm and 7.2 °C of A, MAP and MAT, respectively. The lower productive site (LPS) had 550 m.a.s.l., 440 mm and 5.9 °C of A, MAP and MAT, respectively. The mean H in HPS were 12.3 m for ñire and 18.5 m for lenga, while in LPS the H were 7.2 m for ñire and 12.6 m for lenga.

Leaves sampling and analyses

In the summer (peak growth period), around 1000 fully sunlit mature green leaves were collected randomly from five trees (200 leaves per tree) of both studied species (*N. pumilio* and *N. antarctica*), at each of the two sites. In autumn (late May), senescing leaves (yellow color) were collected from the same selected trees. For both species and dates, samples were immediately taken to the lab in closed plastic bags and kept at 3 °C in the refrigerator until processing. Tissue was carefully washed with 0.1% detergent to remove surface contaminants and rinsed with abundant tap and then distilled water. They were subsequently oven dried at 70 °C for 2 days, weighed and ground prior to mineral element (N, P and K) determination. Nutrients concentrations in green (Ngr) and senesced (Nsen) leaves were used to calculate nutrient resorption efficiency (NRE), according to the following formula:

$$NRE = ((Ngr - Nsen) + Ngr) x\, MLCF\ x\, 100$$

Where MLCF is the mass loss correction factor, specifically the ratio of the dry mass of senesced leaves and the dry mass of green leaves. To evaluate differences among species and sites, data were analysed with ANOVA.

RESULTS AND DISCUSSION

Nitrogen concentration decreased significantly from green to senesced leaves in both species and for the two studied sites. However, differences among species only were detected for senesced

leaves in the HPS site (Table 1). Phosphorus concentration diminished significantly from green to senesced leaves only in the LPS site and differences among species were only determined in green leaves in the same site, while *N. pumilio* green leaves showed differences among sites (Table 1). In the case of K, differences among green and senesced leaves concentrations were found in all cases and also differences among species were detected in most of situations (Table 1). Nutrient resorption did not vary between species for the same site or between sites for the same species, averaging 58, 37 and 53 % for N, P and K, respectively. The concentrations in green and senesced leaves and therefore also the estimated resorption efficiency, are within the reported by Diehl et al. (2008) for N and P in four deciduous *Nothofagus,* including the species we analysed*,* but from northern Patagonia. However, our results contrasted with nutrient resorption values obtained by Chatain et al. (2009) for *Nothofagus* species growing in the tropical environment of New Caledonia, where they measured lower N, higher P and similar K resorption rates. In light our our results, no differences in nutrient resorption efficiency attributable to environmental conditions could be identified. Nevertheless the obtained results supported the hypothesis that N supply typically limits plant growth in temperate forests, while P limits tropical forests (Cleveland et al. 2002; Vitousek and Howarth 1991).

Table 1. Nutrients concentrations (% dry weigth, D.W.) in green and senesced leaves of two co existing *Nothofagus* species growing in a higher (HPS) and a lower productivity site (LPS), in southern Patagonia.

Site	Specie	N (% D.W.)		P (% D.W.)		K (% D.W.)	
		green	senesced	green	senesced	green	senesced
HPS	*N. antarctica*	1.8±0.2a	1.0±0.5b	0.21±0.03	0.17±0.11	0.7±0.2a	0.4±0.2bA
	N. pumilio	1.8±0.1a	0.7±0.1b	0.26±0.12B	0.17±0.10	1.1±0.2a	0.6±0.1bA
Sig.		ns	*	ns	ns	***	*
LPS	*N. antarctica*	2.1±0.2a	0.9±0.5b	0.26±0.08a	0.15±0.08b	0.5±0.2a	0.2±0.1bB
	N. pumilio	2.1±0.1a	0.8±0.2b	0.43±0.09aA	0.20±0.08b	0.9±0.1a	0.3±0.1bB
Sig.		ns	ns	**	ns	***	ns

Sig.: indicates differences among species for a same site and type of leaves (ns: not significant; *: P<0.05; **: P<0.01; ***: P<0.001). Lowercase letters indicate differences among type of leaves for a same specie and site. Capital letters indicate differences among sites for a same specie and type of leaves.

CONCLUSIONS

Contrasting environmental conditions did not have an marked effect on the N, P and K resorption rates of the two *Nothofagus* species evaluated. More research is required to evaluate the nutrient resorption efficiency of Southern Patagonian forests and expanding the spatial and temporal experimental scale, among other factors

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