

ON REPEATED BROWSING OF SCOTS PINE SAPLINGS BY MOOSE (*ALCES ALCES*)

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Seloste

MÄNNYNTAIMIEN TOISTUVASTA HIRVIVIOITUKSESTA

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The size, nutrient contents and terpene composition of needles of untouched and repeatedly browsed pine saplings were compared. The needles of damaged pines were significantly larger but only slight differences occurred in the needle chemistry.

INTRODUCTION

A recent study on the damage caused by moose (*Alces alces* L.) to young Scots pine (*Pinus sylvestris* L.) stands revealed that during the first feeding in a stand the moose would taste pine saplings quite randomly (Löyttyniemi and Piisilä 1983). Then if a sapling is found palatable, it tends to be heavily damaged even during the first feeding season and will probably be rebrowsed during the next winters as well. Thus the selection of a host tree even in the case of repeated damage is made by the moose on the basis of the original properties of the tree. However,

repeated browsing may be promoted also by some induced changes in needles when the tree is replacing lost organs of assimilation (cf. Löyttyniemi 1981).

In the present study, some physical and chemical properties of needles of untouched and repeatedly browsed pine saplings are compared. The study is a part of screening tests on the effect of chemical composition of pine in relation to browsing preference by the moose (Löyttyniemi and Hiltunen 1978, Löyttyniemi 1981).

MATERIAL AND METHODS



The material was collected from a Scots pine plantation in Bromarv, South Finland. The age of the saplings was 14 years and average height 2.5 m. In the stand, 42 sample trees were selected in pairs so that one pair member was repeatedly browsed by moose, the other being the nearest untouched sapling.

Needle samples for the analyses were taken from the current shoots of the uppermost parts of the saplings in November, 1981 (see Fig. 1). The average length and fresh and dry weights of the needles were measured (50 needles per a tree). Nutrient (N, P, K, Ca, Mg, B, Cu) contents were determined using the established methods, and the volatile needle oil analyzed using the methods described by Löyttyniemi et al. (1982).

Fig. 1. Top of repeatedly browsed pine sapling, recovered for one growing season from the last damage.

RESULTS AND DISCUSSION

Damage caused by a herbivore can induce physical and chemical changes in the host plant which may affect recovery and further resistance (e.g. Schwerdtfeger 1970, Crawley 1983). In the case of moose and Scots pine, good recovery of damaged saplings have been demonstrated (Kangas 1949, Löyttyniemi 1983, Löyttyniemi and Piisilä 1983). However, possible changes in the properties of the tree induced by browsing are poorly known (cf. Haukioja et al. 1983).

In this material, the needles of the repeatedly browsed pines became long and robust, resembling those of fertilized trees (Löyttyniemi 1981, Kellomäki et al. 1982). The needles were on average 17 % longer and 35 % heavier (d.w.) than those of the untouched pines. There was, however, no differ-

ence in the dry matter percentage (40 % for both lots). Because moose is commonly known to prefer robust hypertrophied pine needles (Kangas 1949, Morow 1976, Löyttyniemi 1981; see also Thalenhorst 1968, Oh et al. 1970), the growth response even when induced by browsing damage is probably increasing palatability of needles and thus promoting rebrowsing.

There were some differences in the nutrient concentrations in needles between the rebrowsed and untouched pines. The average nitrogen content was higher in the rebrowsed trees (1.67 % vs. 1.50 %; $t=4.53^{***}$). Compared with previous information of the nitrogen contents of pine needles in corresponding conditions (e.g. Viro 1965, Löyttyniemi 1981), it seems that nitrogen has slightly

increased from the original level due to browsing damage. The nitrogen content is, however, not directly correlated with the palatability of pine needles (Löyttyniemi 1981, Salonen 1982, Haukioja et al. 1983).

The phosphorus content was also higher in the damaged trees (1.84 mg/g vs. 1.68 mg/g; $t=2.43^*$). The phosphorus content of browsed pine saplings has been, however, found to be usually slightly higher even before the first damage (Löyttyniemi 1981). Thus the difference may not have been induced by browsing.

In addition, also the boron content was slightly higher in the needles of repeatedly browsed pines (17.2 ppm vs. 14.8 ppm; $t=2.60^*$). In general, these contents are relatively high for pine (cf. Möller 1983, Reinikainen and Veijalainen 1983).

No evident need of boron has been demonstrated for animals, although boron plays an important role as a necessary trace element for the growth and development of plants (e.g. Kliegel 1980). Boron is involved, for example, in the metabolism of secondary constituents as auxin and phenols. In young pines, the boron content is related to the condition of the leader and uppermost shoots (e.g. Kolari 1983). Thus the higher concentration of boron in the needles of repeatedly browsed pines would be connected with the recovering process, having no direct effect on palatability.

No differences occurred in the contents of calcium, potassium, magnesium and copper between the browsed and control pine saplings (cf. Löyttyniemi 1981, Haukioja et al. 1983). In general, the relative contents of calcium and magnesium in current pine needles are known to decrease along lusher growth (e.g. Heinze 1973, Löyttyniemi 1981).

One oxygenated monoterpene, seven ses-

quiterpene and 12 monoterpene compounds were detected in the needle oil. There were, however, only slight differences in the composition of the oil between the plant groups: the relative proportions of monoterpenes tricyclene and camphene were slightly higher ($P<0.05$) in the untouched trees. However, monoterpene composition may not play any significant role in the selection of pine forage by moose (Löyttyniemi and Hiltunen 1978; see also Oh et al. 1967, Schwartz et al. 1980, Haukioja et al. 1983).

These preliminary results suggest that only needle size may have direct correlation with the palatability of the needles. Thus, although the predisposition to suffer from repeated browsing is mainly based on the original -so far mostly unknown- properties of the tree, the induced lusher growth during the recovery presumably increases the probability and intensity of rebrowsing to some extent. Rebrowsing may also be promoted by the improved accessibility resulted from reduced height development after leader damage. In the present material, however, even the control saplings were still in the vulnerable size (see Löyttyniemi and Piisilä 1983).

On the other hand, the high palatability of repeatedly browsed pines would indicate that moose damage does not induce any resistance in the host tree (cf. Bryant and Kuropat 1980), which corresponds to the food selection by some other pine feeders (e.g. Pulliainen 1970, Farentinos et al. 1981).

Further studies using simulated browsing of host and non-host pines with detailed initial control analysis are, however, needed for a proper understanding of this phenomenon, and for evaluating artificial shoot pruning as a suggested method to improve the quality of winter forage for moose (Löyttyniemi and Piisilä 1983).

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SELOSTE

MÄNNYNTAIMIEN TOISTUVASTA HIRVIVIOITUKSESTA

Tutkimuksessa verrattiin hirven toistuvasti vioittamien ja koskemattomien männyntaimien neulasien kooka, ravinnepitoisuuksia ja terpeenihilivetykoostumusta. Vioitettujen taimien neulasat olivat kehittyneet suuremmiksi kuin koskemattomien taimien, mutta erot neulasien kemiallisessa koostumuksessa olivat vähäisiä. Sa-

mojen taimien toistuvan syönnin oletetaan saatujen tulosten perusteella johtuvan enemmän taimien alkuperäisistä ominaisuuksista kuin toipumisprosessin yhteydessä tapahtuvista maistuvuutta lisäävistä muutoksista. Neulasien koon suureneminen saattaa tosin jossain määrin lisätä toistuvan syönnin todennäköisyyttä ja määrää.