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## Outdoor shelter for grazing sheep: what impact of tree density on sheep behaviour, welfare and performance?

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Ruminants reared outdoors are confronted with various climatic hazards that can affect their welfare, and trees can provide potential shelter. The present study tested the effect of tree density in pasture on the behaviour, welfare and performance of sheep, in different geographical contexts. Six grassland plots in north-west (NWG) and three in a semi-mountainous area of central France (SMG) were investigated. The NWG, consisting of lowland meadows with adult fruit trees, were grazed by groups of minimum 15 ewes. Plots either contained few trees (Control, C) or were treed (T). The SMG, planted with adult cherry wood and maple trees at different densities (C: 1 tree, T+: 60 trees/ha, T++: 150 trees/ha) were continuously grazed by 10 ewes (and their lambs until weaning) over the grazing season. Ewes' activity and position relative to shade were observed over periods of 2 to 4 days (6 to 7.5h / day) in spring and summer of 2016 and 2017, simultaneously on plots C and T, or C, T+ and T++. Reactions to insects and respiratory rate were also carried out, as well as ewes and lambs' performance in SMG. Data were analysed with the SAS Enterprise Guide® software (Proc MIXED), for testing the effects of treatment and date, season or year (repeated statement) depending on the analysis. The proportion of time spent in the shade increased with tree density (35% (C) vs. 43% (T),  $p < 0.001$  in NWG; 30% (C) vs. 73% (T+) vs. 88% (T++),  $p < 0.0001$  in SMG), as well as with the increase in a heat load index (HLI, calculated in SMG from meteorological data,  $p < 0.0001$ ). Animals actively selected the shade provided by the trees, even outside the hottest summer days, and despite greater reactions to insects under the trees ( $p < 0.01$ ). Ewes mobilized their reserves more strongly on the tree-planted plots ( $P < 0.05$ ), but only in 2016. All of them ensured a correct growth of their lambs. Trees on grassland represent an enrichment that the sheep actively use for shelter.