Effect of Grassland Management on the Occurrence of the Poisonous Species *Senecio jacobaea*

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Introduction *Senecio jacobaea* L . (tansy ragwort) is a poisonous weed in grasslands of various continents (e .g . United States , Great Britain , Central Europe , New Zealand) . In Central Europe , the species seems to have increased its dispersion in the last years . The further spread of the species into farmland must be prevented because *S . jacobaea* contains pyrrolizidine-alkaloids that are toxic for cattle and other livestock (Duby , 1975) . We thus conducted a survey in Switzerland to assess the influence of management practice and site conditions on the occurrence of this species . Our aim was to find a combination of conditions where the risk for the occurrence of *S . jacobaea* was either remarkably high or low . Such data will allow strategies to hinder the weed's dispersion .

Materials and methods To reveal links between management practices and the occurrence of *S . jacobaea* , a case-control study (Agresti , 2002) was conducted on agricultural grassland in the northern and central part of Switzerland . Botanical assessments were conducted on parcels (management units) with *S . jacobaea* occurrence (cases) and on neighbouring parcels without *S . jacobaea* (controls) . For all parcels , we analysed the soil nutrients , texture and pH , and the details of management such as intensity of fertilisation and frequency of defoliation . The influence of the recorded parameters on the occurrence of *S . jacobaea* was analysed using multiple logistic regression , the response variable being the presence or absence of *S . jacobaea* . The recorded variables were tested with forward selection , and the approximate relative risk , the ratio of the probability of presence of the weed for two levels of an environmental variable , was calculated following Agresti (2002) .

Results All important factors influencing the occurrence of *S . jacobaea* were related to management (Table 1) : Doubling the application of nitrogen to 100 kg ha^{-1} yr^{-1} reduced the risk for *S . jacobaea* occurrence approximately five-fold (0 .19 , Table 1) . This means that the species occurred less frequently on intensively fertilised parcels , but had a high risk for occurrence on grasslands with low nitrogen fertilisation . Swards that had a high percentage of bare soil (> 25%) had a forty-fold greater risk for the occurrence of the species than swards with an bareness of less than 25% . Finally , parcels that were under continuous-extensive grazing (set stocking) had an approximately eleven-fold greater risk for the occurrence of *S . jacobaea* compared to mown grassland , while rotational grazing did not show significant differences in risks compared to mowing . *S . jacobaea* was not present in intensively managed meadows cut more than twice per year . As an exception , with a high propagule pressure from the vicinity , *S . jacobaea* was also found in intensively grazed pastures and in meadows of moderate management intensity (two cuts) .

Conclusions A long-term control of *S . jacobaea* can best be achieved by avoiding sward damage , by replacing continuous-extensive by rotational grazing , and by preventing the species seed formation in the pasture and the local vicinity . We also conclude that on-farm surveys conducted as a case-control study are very powerful as they provide reliable data in relatively short time (Suter et al . , 2007) . Species occurrence can be linked to the management practice on farms and a wide range of environmental conditions existing over longer periods .

Table 1 *Variables with relevant effects on the occurrence of* S . jacobaea . *Estimates of multiple logistic regression and the calculated relative risk . Significant effects at* $P \leq 0.05$ *are in bold .*

Variable	Regression estimate	Relative risk (compared to the intercept)
Intercept†	-1 .509	
Nitrogen-applied	-0 .033	**0 .19**♣
Openness : High (> 25%)	3 .696	**40 .31**
Rotational grazing *vs* mowing	-0 .055	0 .95
Continuous grazing *vs* mowing	2 .447	**11 .56**
R^2	0 .658	

† The intercept represents grassland that was mown , received available nitrogen of 50 kg ha^{-1} yr^{-1} , and had a low openness of sward (≤ 25%)
‡ Relative risk for applied nitrogen of 100 kg ha^{-1} yr^{-1}

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