

**Annotated Bibliography on the  
Ecology and Management of Invasive Species:**

**Sweet vernalgrass (*Anthoxanthum odoratum*)**

**Prepared by Judith Cullington & Associates, Victoria, BC  
for the Garry Oak Ecosystems Recovery Team  
and the Nature Conservancy of Canada**

*Funding supplied by the Habitat Stewardship Program of the Government of Canada*

**March 2002**

**Bekker-R-M {a}; Knevel-I-C {a}; Tallowin -J-B-R; Troost-E-M-L {a}; Bakker-J-P {a}, 1998**

Title: Soil nutrient input effects on seed longevity: A burial experiment with fen-meadow species.

Source: Functional-Ecology. Aug., 1998; 12 (4) 673-682.

Publication Year: 1998

Language: English

Abstract: 1. Effects of high nutrient input on the longevity and viability of buried seed are examined. Seeds of 17 fen-meadow species were buried in nylon mesh bags at four sites in the Netherlands and one site in Great Britain in plots to which N, P, K fertilizers are applied. Prior to burial germination tests were conducted on the seeds of each species. This paper describes the results of the viability tests on the seeds that were exhumed after one and 2 years of burial. 2. The percentage of seeds that germinated after 1 year of burial was significantly lower than the pre-burial percentage for the majority of the species. After 2 years of burial the germination percentage further decreased. A few species, such as the *Carex* species, did, however, show an increase in germination percentage indicating that the burial conditions allowed dormancy controls to be broken. 3. Differences in the edaphic conditions between the sites appeared to affect germination percentages after 1 year of burial. A difference in germination response between sites was observed for *Carex acutiformis*, *Filipendula ulmaria* and *Lychnisflos-cuculi*. 4. A significantly higher germination percentage was found at the Great Britain site for *F. ulmaria* in the phosphate treatment compared with the potassium treatment and the control after 1 year of burial. In contrast to many literature assessments no significant effects of fertilizer application was found after 2 years. 5. For all sites, except one in the Netherlands, the total number of seeds that germinated was lower in 1996 than in 1995.

**Clark-Deborah-L {a}; Wilson-Mark-V {a}, 2001**

Title: Fire, mowing, and hand-removal of woody species in restoring a native wetland

prairie in the Willamette Valley of Oregon.

Source: Wetlands-. [print] March, 2001; 21 (1): 135-144.

Publication Year: 2001

Language: English

Abstract: The invasion of prairies by woody species is a worldwide conservation concern. Fire is frequently used to inhibit this invasion. However, there is little documentation of the effect of fire in wetland prairies, which are also threatened with encroachment of woody species. The present study investigated wetland species responses to experimental burning, hand-removal of woody species, and mowing with removal of cut material. The possible ecological mechanisms responsible for individualistic responses of species, including direct mortality, ability to resprout, and release from competition are considered. We also evaluated these treatments as tools for meeting restoration objectives of reducing the abundance of woody species, reducing or preventing spread of non-native pest species, and increasing or at least maintaining native species' abundance. After two years of treatments (1994 and 1996) three patterns emerged. 1) Woody species: Burning and hand-removal caused the greatest reductions in cover of woody species. Mowing with removal of cut material, however, did not reduce the cover of woody species compared to controls. As woody plant cover decreased, plant mortality increased, indicating that treatments influenced woody plant cover at least partially through mortality. 2) Native herbaceous species: Burning significantly decreased inflorescence production of *Deschampsia cespitosa*, the dominant wetland prairie grass. In contrast, burning, along with mowing, significantly increased flowering of *Juncus tenuis*. Flowering and cover of all native graminoids combined, however, showed no significant responses to treatments. Burning and hand-removal significantly promoted the cover of native forbs as a group, with *Lotus purshiana* and *Veronica scutellata* showing the greatest increases. 3) Non-native herbaceous species: Burning and hand-removal significantly reduced the cover of non-native forbs as a group and particularly reduced the cover of *Hypericum perforatum*. The number of inflorescences of non-native grasses (*Holcus lanatus* and *Anthoxanthum odoratum*) increased with hand-removal and mowing. Overall, no treatment was clearly superior in fulfilling the restoration objectives. Burning was effective in reducing woody cover and did not promote abundance of non-native herbaceous species. Burning, however, reduced the flowering of the key native grass, *Deschampsia cespitosa*. Hand-removal of woody species was also effective at reducing woody cover and promoted the abundance of some native species, but it sometimes increased the cover of non-native herbaceous species. Because mowing with removal of cut material was ineffective in reducing woody cover and tended to promote non-native herbaceous species, this treatment is not recommended as a management tool.

**Crawley-M-J {A}, 1990**

Title: Rabbit Grazing Plant Competition And Seedling Recruitment In Acid Grassland.

Source: Journal-of-Applied-Ecology. 1990; 27 (3): 803-820.

Publication Year: 1990

Language: ENGLISH

Abstract: (1) Two experiments were done to determine the effects of grazing by rabbits on plant recruitment in mature grassland and on cultivated soil. The first was a factorial experiment, with and without rabbit fencing, and with and without soil cultivation, carried out between 1986 and 1989 in acid grassland with a long history of rabbit grazing. In the second, carried out between 1982 and 1985 in two contrasting arable fields, rabbits grazed crops of winter wheat, with fencing exclosures erected at different times and for different durations. (2) Rabbit grazing affected the stature and composition of the grassland throughout the year. Species that increased in cover in rabbit-grazed grassland included the grass *Anthoxanthum odoratum* and the forb *Rumex acetosella*. Species that decreased included the grasses *Festuca rubra* and *Agrostis capillaris* and the forbs *Vicia sativa* and *Trifolium repens*. There was negligible change in the total number of plant species with grazing. (3) The cultivated treatments showed that the seed bank under the acid grassland was extremely heterogeneous. (4) Eight of the twenty-three commonest ruderal species beneath acid grassland decreased in cover significantly (e.g. *Capsella bursa-pastoris* and *Papaver dubium*), and none increased significantly. In contrast, most of the ruderal species in the seed bank of nearby arable soils increased under grazing. (5) Most plants species on cultivated grassland soils regenerated from vegetative fragments (e.g. *Holcus mollis*, *Stellaria graminea*, *Rumex acetosa* and *R. acetosella*), rather than by germination of seed. Regrowth shoots outnumbered seedlings by a factor of between 1.3 and 23.3. (6) The extent of spatial heterogeneity within and between plots in both the composition of the buried seed bank, and in recruitment by vegetative regrowth, highlights the need for large sample size in this kind of study. (7) The mechanisms that determine whether a plant species increases or decreases under grazing are discussed.

### **Domeij,-A, 1948**

TITLE: The sensitivity of some wood and meadow plants to sodium chlorate.

SOURCE (BIBLIOGRAPHIC CITATION): 1948, Medd. Skogsforskn Inst., Stockh. 1948 37 (6), pp. 16. 8 refs.

ABSTRACT: Observations over a period of 3 years on the effect of different concentrations of sodium chlorate on vegetation in, an Oak and mixed coniferous wood show that plants vary in their sensitivity. *Calluna vulgaris* and *Hypericum quadrangulum* are killed at concentrations of 2.5-5 g./sq. m., *Vaccinium myrtillus* at 5, *Pteridium aquilinum* at 10, and *Trifolium medium*, *Veronica chamaedrys*, *Melampyrum pratense*, *Linnaea borealis*, *Vaccinium vitisidaea* and *Polytrichum commune* at 10-20 g./ sq. m. Young *Picea abies* shed their leaves at 10 g./sq. m. and died at higher concentrations. *Cirsium arvense*, *Urtica dioica* and *Agropyron repens* are fairly sensitive. *Anemone nemorosa*, *Lathyrus sylvestris*, *Convallaria majalis*, *Orchis maculata*, *Habenaria bifolia*, *Anthoxanthum odoratum*, *Majanthemum bifolium*, *Oxalis acetosella*, *Hylocomium parietinum* and *H. proliferum* survive at concentrations from

20 to 40 g./sq. m. *Potentilla erecta*, *Trientalis europaea*, *Luzula pilosa* and *Orobus tuberosus* are resistant at concentrations of 40 g./sq. m. Trees and bushes, except young *Picea abies*, are largely resistant at concentrations of 50 g./sq. m. (the limit of the experiment). *Pinus sylvestris* and *Juniperus communis* appear to be insensitive to the salt; *Quercus robur*, *Betula verrucosa*, *Sorbus aucuparia*, *S. suecica* and *Populus tremula* are uninjured and their growth appears to be promoted, probably owing to decreased root competition. From author's summary.

DESCRIPTORS: *Betula-verrucosa-resistant-to-sodium-chlorate*; *Calluna-vulgaris-chemical-control*; *Juniperus-communis*; *Picea-abies-effect-of-NaClO<sub>3</sub>, -on-young-plants*; *Pinus-sylvestris-resistant-to-NaClO<sub>3</sub>*; *Populus-tremula-effect-of-herbicide-sprays*; *Pteridium-aquilinum*; *Quercus-robur-s.l.-uninjured-by-NaClO*; *Sorbus-aucuparia*; *Sorbus-suecica*; *Vaccinium-myrtillus*; *Weed-killers*; *Weed-trees-and-shrubs-chemical-control*; *Weeds-chemical-control*

**Edwards-G-R {a}; Clark-H; Newton-P-C-D, 2001**

Title: The effects of elevated CO<sub>2</sub> on seed production and seedling recruitment in a sheep-grazed pasture.

Source: *Oecologia-Berlin*. [print] May, 2001; 127 (3): 383-394.

Publication Year: 2001

Language: English

Abstract: Seed production and seedling recruitment were measured over 2 years under ambient (360 ppm) and elevated (475 ppm) atmospheric CO<sub>2</sub> in a free air carbon dioxide enrichment (FACE) experiment, carried out in a sheep-grazed pasture on dry, sandy soil in New Zealand. In both years elevated CO<sub>2</sub> led to more dispersed seeds of the grasses *Anthoxanthum odoratum*, *Lolium perenne* and *Poa pratensis*, the legumes *Trifolium repens* and *T. subterraneum* and the herbs *Hypochaeris radicata* and *Leontodon saxatilis*. The increased seed dispersal in *A. odoratum*, *H. radicata*, *Leontodon saxatilis* and *T. repens* reflected both more inflorescences per unit area and more seeds per inflorescence under elevated CO<sub>2</sub>. The increased seed dispersal in *Lolium perenne*, *P. pratensis* and *T. subterraneum* was due solely to more inflorescences per unit area. The number of seedlings that emerged and survived to at least 7 months of age was increased by elevated CO<sub>2</sub> for *H. radicata*, *Leontodon saxatilis*, *T. repens* and *T. subterraneum* in both years and for *A. odoratum* and *Lolium perenne* in the first year. For species where increased seedling recruitment was noted, there was a significant positive correlation between seed production in summer and seedling emergence in the following autumn and winter, and sowing 200 extra seeds per species m<sup>-2</sup> resulted in more seedlings compared to unsown controls. Elevated CO<sub>2</sub> did not affect seedling survival in any species. There was no measurable effect of elevated CO<sub>2</sub> on canopy and soil surface conditions or soil moisture at the time of seedling emergence. The results suggest the dominant effect of elevated CO<sub>2</sub> on seedling recruitment in this pasture was an indirect one, reflecting effects on the

number of seeds produced. The biomass of *H. radicata*, *Leontodon saxatilis*, *T. repens* and *T. subterraneum* in the aboveground vegetation was greater under elevated than ambient CO<sub>2</sub>. However, the size of individual seedlings and mature plants of these four species was unaffected by elevated CO<sub>2</sub>. The results indicate an important way elevated CO<sub>2</sub> influenced plant species composition in this pasture was through changes in the pattern of seedling recruitment.

**Elberse-W-T; Berendse-F, 1993.**

Title: A comparative study of the growth and morphology of eight grass species from habitats with different nutrient availabilities.

Source: *Functional-Ecology*. 1993; 7 (2) 223-229.

Publication Year: 1993

Language: English

Abstract: To find out which properties enable plant species to dominant in nutrient-poor habitats and which properties benefit species in nutrient-rich habitats, we studied the growth and morphology of eight perennial grass species from habitats with contrasting soil fertilities in a pot experiment under controlled conditions in a glasshouse. The species were grown under nutrient-poor and nutrient-rich conditions. Ranked from the least responsive to the most responsive to the supply of nutrients they were: *Festuca ovina*, *F. rubra*, *Anthoxanthum odoratum*, *F. arundinacea*, *Alopecurus pratensis*, *F. pratensis*, *Arrhenatherum elatius*, *Lolium perenne*. The response correlated positively with the Ellenberg nitrogen number of the species. No differences in initial relative growth rate was found between the species, but after 4 weeks the plant dry weight increased with increasing nitrogen number as a result of variation in embryo plus endosperm weight. Species characteristic of nutrient-rich hayfields are taller and show a more homogeneous vertical distribution of photosynthetic area than the species from nutrient-poor habitats, which have most of their leaf area below 15 cm. Species from the nutrient-poor habitats allocated less dry matter to the roots and consequently more to the shoot, than species from nutrient-rich conditions. However, leaf and root morphology seem to be most clearly adapted to the habitat. Species from nutrient-rich habitats have a higher specific leaf area (SLA) than species from nutrient-poor habitats, while species from nutrient-poor habitats had more root length per unit root weight (SRL) than species from nutrient-rich habitats.

**Hester-A-J {A}; Gimingham-C-H; Miles-J, 1991**

Title: Succession From Heather Moorland To Birch Woodland Iii. Seed Availability Germination And Early Growth.

Source: *Journal-of-Ecology*. 1991; 79 (2): 329-344.

Publication Year: 1991

Language: ENGLISH

Abstract: (1) This paper examines seed input, germination and early growth of species found during the succession from heather moorland to mature birch woodland. (2)

Numbers of seeds of *Calluna vulgaris* in the seed rain decreased rapidly with increasing age of birch stands. Large numbers of *Calluna* seeds were found, however, in soil beneath all ages of birch as well as the open moor, illustrating the longevity of seeds of this species. (3) Large numbers of *Deschampsia flexuosa* seeds arrived in the seed rain but very few germinated from the soil, indicating dependence on immediate seed regeneration, unlike *Agrostis capillaris* which had large, persistent soil seed stores. (4) The presence of seeds of *Anthoxanthum odoratum*, *Agrostis capillaris* and *Rumex acetosella* in seed rain and soil seed stores showed that the absence of these species from open moorland and young birch was not due to unavailability of propagules. (5) Germination of the species studied was apparently not affected by stand age, with the exception of *Agrostis capillaris* and *Cerastium holosteoides* which showed reduced germination on the open moor. Early growth of most species was faster, however, beneath the birch than on the open moor and improved beneath increasing ages of birch. (6) The natural regrowth of vegetation in the cleared plots was faster beneath the older birch than the young birch or the open moor. (7) The implications of differences in seed availability, germination and early growth are discussed in relation to observations and experiments on species changes beneath developing birch reported in the first two papers of this series.

#### **Holgate-GL, 1986**

TITLE: A role for goats in range utilization and shrubweed control on New Zealand's pastoral lands.

SOURCE (BIBLIOGRAPHIC CITATION): Rangelands: a resource under siege. Proceedings of the 2nd International Rangeland Congress, Adelaide, Australia, 13-18 May 1984. 1986, 296-297; 6 ref.

ABSTRACT: Merino sheep, feral goats and Angora goats were set-stocked at equivalent liveweight/ha in 0.5-ha paddocks of *Agrostis capillaris*/*Anthoxanthum odoratum* infested with *Rosa rubiginosa*. Goats rapidly reduced the size of *R. rubiginosa* plants whereas sheep had little effect. After 2 years, *Trifolium repens* cover was significantly greater where Angoras grazed than in the other 2 treatments.

DESCRIPTORS: grazing-; population-dynamics; control-; Scrub-; scrub-control; Weeds-; biological-control; Crops-; rangelands-

#### **Karpa-DM; Vitousek-PM, 1994**

TITLE: Successional development of a Hawaiian montane grassland.

SOURCE (BIBLIOGRAPHIC CITATION): *Biotropica*. 1994, 26: 1, 2-11; 17 ref.

ABSTRACT: Substrate and elevation fundamentally affect the primary successional fate of plant communities on Mauna Loa Volcano, Hawaii. Native perennial grasslands dominated by *Deschampsia nubigena* form after initial forest development within well-defined elevational limits on pahoehoe lava flows. Woody vegetation continues to dominate at both higher and lower elevations. Woody vegetation is also dominant at all elevations of 'a'a flows. The exotic perennial grass, *Anthoxanthum odoratum*, has

invaded sites where *D. nubigena* is a major component of the vegetation.

DESCRIPTORS: woody-plants; forests-; grasslands-; disturbed-land; mountain-grasslands; plant-succession; volcanic-areas; altitude-; plant-communities; mountain-forests

**Mamolos-A-P; Veresoglou-D-S {a}; Noitsakis-V; Gerakis-A, 2001**

Title: Differential drought tolerance of five coexisting plant species in Mediterranean lowland grasslands.

Source: *Journal-of-Arid-Environments*. [print] October, 2001; 49 (2): 329-341.

Publication Year: 2001

Language: English

Abstract: To investigate how soil water content affects plant productivity; phenology and changes in aboveground biomass of five species were recorded in a Mediterranean lowland grassland during a relatively wet year (1991) and a dry year (1992); soil-water potentials were related to changes in soil water content. Species examined were the early-season C3 grasses *Poa bulbosa* and *Anthoxanthum odoratum*, the late-season C4 grasses *Chrysopogon gryllus* and *Cynodon dactylon*, and the mid-season C3 forb *Rumex acetosella*. Species were also grown as monocultures in pots under two watering treatments (irrigation, no irrigation). The soil-water potential at the times of maximum aboveground biomass for *Poa* and *Anthoxanthum* were similar in the un-irrigated pots and in the dry year (1992) in the field. Aboveground biomass of all species in the field, except *Cynodon*, was lower in 1992 than in 1991. The early-season species *Poa* and *Anthoxanthum* showed the greater decrease in biomass in response to drought, and tended to exhibit an earlier maximum aboveground biomass. Similarly, these species exhibited an earlier maximum shoot biomass in the un-irrigated pots than in the irrigated pots. The mid- and late-season species tolerated lower soil matric potential. In comparison with the early-season species, they had higher leaf water potentials and greater values of relative water content when leaf water potential was lower than -1.5 MPa. These results indicate that the early-season species are more drought-sensitive than late-season species and that their productivity and phenology is influenced greatly by variation in soil water content between years.

**Mills-Katherine-E; Bever-James-D {a}, 1998**

Title: Maintenance of diversity within plant communities: Soil pathogens as agents of negative feedback.

Source: *Ecology-Washington-D-C*. July, 1998; 79 (5) 1595-1601.

Publication Year: 1998

Language: English

Abstract: The effect of soil pathogens on plant communities was investigated using four old-field perennial plant species and five isolates of a pathogenic oomycete in the genus *Pythium*. These *Pythium* strains were isolated from the roots of two of the plant species, *Danthonia spicata* and *Panicum sphaerocarpon*, used in a previous experiment on the

consequences of changes in the soil community on plant growth. In this previous experiment, *Danthonia* and *Panicum* changed the soil community in a manner that reduced their growth relative to that of a third plant species, *Anthoxanthum odoratum*. In the current experiments, we found that inoculation with *Pythium* reduced overall plant mass and root: shoot ratios, but *Danthonia* and *Panicum* were more susceptible to the presence of *Pythium* than the other two plant species, *Anthoxanthum* and *Plantago lanceolata*. In addition, *Pythium* accumulates at different rates on different plant species, with a greater than tenfold higher population observed in association with *Panicum* compared to *Anthoxanthum*. The results of these experiments suggest that the accumulation of species-specific soil pathogens could account for the previous observation of negative feedback on plant growth through changes in the soil community. As negative feedback may act to maintain plant species diversity within a community, these results suggest that soil pathogens may themselves contribute to the maintenance of plant species diversity.

**Pitcher, Don and Mary Russo, 1988**

Element Stewardship Abstract for *Anthoxanthum Odoratum*, Sweet Vernal Grass. The Nature Conservancy

**Pollock-K-M; Scott-D, 1993.**

Title: Introduction, production, and persistence of five grass species in dry hill country: 3. High country, Tekapo, New Zealand.

Source: *New-Zealand-Journal-of-Agricultural-Research*. 1993; 36 (1) 19-24.

Publication Year: 1993

Language: English

Abstract: Grass species were rotary-hoe-drilled into heiracium-dominated fescue tussock. Late autumn and early spring herbage accumulation and composition were determined after three summer grazing treatments (0, 6, and 10 weeks freedom from grazing), and two pre-winter grazing managements. Subplots compared species production and persistence of two superphosphate (P) and three nitrogen (N) fertilizer levels. Over the 7 years, sown grasses only occasionally made significant contribution to the sward. 'Grasslands Apanui' cocksfoot (*Dactylis glomerata* L.) was the best introduced species, reaching dominance in 66% of subplots receiving P and N in the third year. Ryegrass (*Lolium perenne* L.) and tall fescue (*Festuca arundinacea* Schreb.) made some contribution to sward production, and there were only occasional plants of prairie grass (*Bromus willdenowii* Kunth) and tall oat grass (*Arrhenatherum elatius* (L.) Beauv. ex J & C. Presl). The principal response was to fertilizer, with alsike cover (*Trifolium hybridum* L.) responding to P in the early years, and resident fescue tussock (*Festuca novae-zealandiae* (Hack.) Ckn, sweet vernal (*Anthoxanthum odoratum* L.), and browntop (*Agrostis capillaris* L.) to N in later years. Summer spelling increased March herbage mass but decreased late-autumn growth. Pre-winter lax grazing only slightly increased spring growth.



**Sammul-Marek {a}; Kull-Kalevi; Oksanen-Lauri; Veromann-Peeter, 2000**

Title: Competition intensity and its importance: Results of field experiments with *Anthoxanthum odoratum*.

Source: *Oecologia-Berlin*. [print] October, 2000; 125 (1): 18-25.

Publication Year: 2000

Language: English

Abstract: The effect of community productivity on competition was studied in 82 permanent plots using two removal experiments with the rhizomatous perennial grass *Anthoxanthum odoratum*. The removal of neighbouring plants had a positive effect on the number of shoots and total above-ground biomass of *Anthoxanthum* but no significant effect on mean shoot biomass. The relative competition intensity coefficient (RCI) calculated from these data showed that competition intensity increased with increasing community productivity. Similarly, the importance of competition and the difference between local maximum and local average population density increased with increasing community productivity. We concluded that for *Anthoxanthum* the impact of competition is greater in high-productivity areas and that competition reduces population density. No evidence was found supporting the importance of positive interactions between plants in tundra areas.

**Schippers-P {a}; Kropff-M-J, 2001**

Title: Competition for light and nitrogen among grassland species: A simulation analysis.

Source: *Functional-Ecology*. [print] April, 2001; 15 (2): 155-164.

Publication Year: 2001

Language: English

Abstract: 1. A plant competition model to analyse the competition among perennial grassland species was developed. It was used to find out whether complex perennial competition processes could be simulated accurately on the basis of ecophysiological principles; what crucial parameters and processes determine succession; and how spatial heterogeneity affects interspecies competition for light and nitrogen. 2. Simulation results were compared with results of a 2-year replacement experiment involving *Holcus lanatus*, *Anthoxanthum odoratum* and *Festuca ovina*. Sensitivity analyses were performed to evaluate the importance of processes and parameters. 3. The model's sensitivity to plant height, specific leaf area and turnover and the large interspecific differences indicated that these were key determinants of competition between species. *Festuca*'s low shoot turnover enabled it to survive the winter better and gave it an advantage in spring; this resulted in an unexpected recovery after winter in the second year. 4. Spatially explicit simulations showed that species patchiness reduced competitive asymmetry, especially under nutrient-poor conditions. 5. The model's ability to simulate complex perennial competition processes as observed in the experiment indicates its potential for analysing vegetation processes related to

succession.

**Smith-R-S {a}; Buckingham-H; Bullard-M-J; Shiel-R-S; Younger-A, 1996.**

Title: The conservation management of mesotrophic (meadow) grassland in northern England: 1. Effects of grazing, cutting date and fertilizer on the vegetation of a traditionally managed sward.

Source: Grass-and-Forage-Science. 1996; 51 (3) 278-291.

Publication Year: 1996

Language: English

Abstract: The results are reported from an experiment on the effects of cutting date (14 June, 21 July and 1 September), fertilizer application (none or 80 kg ha<sup>-1</sup> N plus 40 kg ha<sup>-1</sup> P and K) and grazing treatments (none, autumn or autumn plus spring) on the vegetation of an upland mesotrophic grassland in Upper Teesdale, northern England, UK. Effects on plant species number and cover are reported for 4 years (1989-93) of treatment. Effects on 'species-attributes' are given for the fourth year. The cessation of grazing combined with the use of fertilizer progressively reduced species number by about 25%. Under traditional management (no fertilizer, cutting date on 21 July, autumn and spring grazing) the species number and cover remained relatively static over the 4 years. Comparison between treatments in the fourth year showed a reduction in species number under the fertilizer application, cutting date on 1 September and no-grazing treatments. Fertilizer use together with cutting date on 1 September particularly lowered species number and cover. Analysis of variance was used to assess the effect of treatment on species that occurred frequently in the sward. A cutting date of 1 September favoured *Agrostis capillaris*, *Alopecurus pratensis*, *Poa trivialis*, *Phleum pratense* and *Trisetum flavescens*. The absence of grazing favoured *Dactylis glomerata* and *Holcus lanatus*. The use of fertilizer particularly favoured *A. pratensis* and *H. lanatus*. Ordination methods were used to assess the effect of treatment on the less frequent species. These were primarily associated with the treatment combination that matched 'traditional' management. Deviations from this 'traditional' regime acted separately, rather than in combination, and favoured different grass species. Traditional management was associated with ruderal, stress-tolerant ruderal and competitive ruderal strategists and with longer seed germination times, heavier seeds, some of which needed scarifying or chilling to break dormancy, and transient seed banks that germinated in the autumn. The original sward was an *Anthoxanthum odoratum*-*Geranium sylvaticum* grassland, *Briza media* subcommunity (MG3b). After 4 years, *Festuca ovina*-*Agrostis capillaris*-*Galium saxatile* grassland, *Holcus lanatus*-*Trifolium repens* subcommunity (U4b) and *Lolium perenne*-*Alopecurus pratensis*-*Festuca pratensis* grassland (MG7c) were found in many of the fertilized and late-cutting treatments.

**Stevens-D-R; Turner-J-D, 1993.**

Title: Introduction, production, and persistence of five grass species in dry hill country:

2. Fairplace, Southland, New Zealand.

Source: *New-Zealand-Journal-of-Agricultural-Research*. 1993; 36 (1) 11-17.

Publication Year: 1993

Language: English

Abstract: As part of a national evaluation series, five grass species were oversown with white clover (*Trifolium repens* L.) into glyphosate-treated plots on a summer-dry northern face of the Hokonui hills, Southland. Swards of these species were compared with the resident pasture, under an annual fertilizer input of 0 or 250 kg superphosphate (0-9-0-11)/ha per year and several 7- or 30-day grazing periods/year. Nui ryegrass (*Lolium perenne* L.) had the highest annual and seasonal pasture yields, especially in spring when pasture yields were at least 18% better than any other grass species. Wana cocksfoot (*Dactylis glomerata* L.) persisted on all slopes and had similar pasture yields to Nui in summer in the first 3 years and in autumn in the final 3 years. Maru phalaris (*Phalaris aquatica* L.) established slowly but spread and persisted to equal the yield of Wana in Year 5 and Nui in Year 6. Although the yield of Matua prairie grass (*Bromus willdenowii* Kunth) was second only to Nui in the first 3 years, it declined rapidly after the management was changed from 2-day grazing to 7- or 30-day grazing. Roa tall fescue (*Festuca arundinacea* Schreb.) did not establish well and never contributed more than 12% to the average pasture yield. The resident pasture always had the lowest annual and seasonal yields, being up to 30% less than Nui pastures. The fertilizer and grazer management treatments had no effect on the relative rankings of the grasses used. Withholding fertilizer resulted in a significant drop in production of 15-20% for the third and subsequent years. Both the sown species and white clover contents were reduced by withholding fertilizer. The 30-day grazing periods significantly reduced pasture productivity by up to 23% when compared to 7-day grazing periods, especially in winter and spring.

**Takahashi-Yoshitaka {a}; Saitoh-Seiji {a}; Otani-Ichiro; Uozumi-Sunao; Hagino-Kouji {a}; Igarashi-Ryozo, 1995.**

Title: Studies in Allelopathic interactions among some grassland species. 6. Screening of allelopathic activities from native grassland species by using the lettuce seed bioassay with the plant shoot extracts.

Source: *Grassland-Science*. 1995; 41 (3) 232-239.

Publication Year: 1995

Language: Japanese; Non-English

Abstract: In order to evaluate the allelopathic potential of plant species commonly grown in semi-natural grassland, lettuce seed bioassay for 141 plants was conducted in laboratory. Lettuce seeds were germinated in petri dishes containing aqueous extracts of shoot from each plant. Three days after seeding, percentage of the germination was determined and radicle and hypocotyl length were measured. The results obtained are summarized as follows: Based on the strong reaction in both germination and seedling growth to the extracts, *Anthoxanthum odoratum*, *Gnaphalium affine*, *Rhododendron*

japonicum and *Corydalis heterocarpa* may be classified in the plants with the most inhibitory activity. Aqueous extracts of *Anthoxanthum odoratum*, *Ixeris stolonifera*, *Gnaphalium affine*, *Glechoma hederacea*, *Rhododendron japonicum*, *Plantago asiatica*, *Plantago lanceolata*, *Barbarea orthoceras*, *Corydalis heterocarpa* and *Sisyrinchium atlanticum* strongly inhibited germination of lettuce seed. Aqueous extract of 15 species, such as *Anthoxanthum odoratum*, *Briza minor*, *Trifolium repens*, *Pueraria lobata*, *Indigofera pseudotinctoria*, *Gnaphalium affine*, *Eupatorium chinense*, *Rubus parvifolius*, *Rhododendron japonicum*, *Hydrocotyle ramiflora*, *Polygala japonica*, *Corydalis heterocarpa*, *Haloragis micrantha*, *Solanum carolinense* and *Phytolacca americana*, considerably reduced radicle and hypocotyl growth of lettuce seedling. Some of the species described above were well known as the alien plants that had become naturalized in Japan.

**Tassin-J; Riviere-JN, 1999**

TITLE: Invasive plants on Reunion.

SOURCE (BIBLIOGRAPHIC CITATION): *Courrier-de-la-Nature*. 1999, No. 177, 28-33; 5 ref.

ABSTRACT: The problems of invasive plants on the island of Reunion are described. Invasive plants include *Hiptage benghalensis* [*Hiptage benghalensis*], *Ligustrum robustum*, *Leucaena leucocephala*, *Rubus alceifolius*, *Psidium cattleianum*, *Syzygium jambos*, *Hedychium flavescens*, *H. gardnerianum*, *Fuchsia magellanica*, *Zantedeschia aethiopica*, *Solanum auriculatum* [*S. mauritianum*], *Acacia mearnsii*, *Ulex europaeus*, *Holcus lanatus*, *Anthoxanthum odoratum*, *Dichrostachys cinerea*, *Lantana camara*, *Schinus terebinthifolius*, *Prosopis juliflora* and *Antigonon leptopus*.

DESCRIPTORS: invasion-; woody-plants; woody-weeds; volunteer-plants; weeds-

**Welch-D; Scott-D, 1995.**

Title: Studies in the grazing of heather moorland in north-east Scotland. VI. 20-Year trends in botanical composition.

Source: *Journal-of-Applied-Ecology*. 1995; 32 (3) 596-611.

Publication Year: 1995

Language: English

Abstract: 1. Botanical composition and herbivore usage were monitored over a 20-year period at 15 moorland sites; point quadrats were recorded in fixed positions. Although composition reflected soil type and altitude, *Calluna vulgaris* was initially the main species at all sites, with cover averaging 61%. 2. Grazing pressures varied from light to heavy, causing wide variation in the utilization of *Calluna* shoots. Hence, *Calluna* declined at four sites, stayed in balance or showed negligible trend at four sites, and increased at seven sites. 3. At sites with *Calluna* decline, oraminoids and forbs showed a general rise in cover, and ericoids and lichens decreased. Species increasing significantly included *Agrostis capillaris*, *Anthoxanthum odoratum*, *Festuca ovina*, *Galium saxatile*, *Luzula multiflora*, *Nardus stricta* and *Rhytidiadelphus squarrosus*;

*Deschampsia flexuosa* was reduced in cover. At one site with agricultural reseeding nearby, *Cynosurus cristatus*, *Dactylis glomerata* and *Lolium perenne* became established. 4. At sites with *Calluna* steady, changes in the main plant groups were small. Bryophytes increased modestly, the chief contributor being *Pleurozium schreberi* which replaced *Hypnum cupressiforme*. 5. At sites with *Calluna* increase, changes were greater when the *Calluna* sward was continuous rather than patchy. At the former sites graminoids and forbs declined sharply, and bryophytes increased, particularly the pleurocarpous mosses *Hylocomium splendens*, *Hypnum cupressiforme* and *Pleurozium schreberi*. 6. Species richness, as measured by the number of contacts with vascular plant species per point-quadrat pin, was much more affected by soil type than by *Calluna* trend. Species number declined somewhat at sites with *Calluna* static and increasing; at sites with *Calluna* decline, an increase in the number of herbs was offset by reduced numbers of bryophytes and lichens.

### ***Useful Websites***

[www.ppws.vt.edu/scott/weed\\_id/aoxod.htm](http://www.ppws.vt.edu/scott/weed_id/aoxod.htm)

Virginia Technical Weed ID Guide

[www.caf.wnu.edu/~forage/library/cangrass/page49.htm](http://www.caf.wnu.edu/~forage/library/cangrass/page49.htm)

Identification of Grasses

[www.denislindsell.demon.co.uk/pasture/grasses/sweetvernalframe.html](http://www.denislindsell.demon.co.uk/pasture/grasses/sweetvernalframe.html)

General information, glossary.

[www.cdsl.tamu.edu/FLORA/taes/tracy/610/anthoxanthum.html](http://www.cdsl.tamu.edu/FLORA/taes/tracy/610/anthoxanthum.html)

Grass taxonomy.

[www.biodiversity.uno.edu/delta/grass/www/anthoxan.htm](http://www.biodiversity.uno.edu/delta/grass/www/anthoxan.htm)

Grass genera of the world.