Biology and Management of *Genista monspessulana* (L.) L.A.S. Johnson (Montpellier Broom)

Janine Lloyd

Thesis submitted for the degree of Doctor of Philosophy

Department of Applied and Molecular Ecology
Faculty of Agriculture and Natural Resource Sciences
University of Adelaide

December, 2000
Abstract

*Genista monspessulana*, a perennial, leguminous shrub, native to the Mediterranean region, is a major weed in native and forest ecosystems in South Australia. It is also considered a major weed in other parts of the world. This study examined the biology of *G. monspessulana* in its native and exotic ranges and investigated the outcomes of potential management strategies involving fire, herbicide and competition.

Seed production, seedbanks, density and ages of *G. monspessulana* population were examined at four sites in South Australia within the exotic range and four sites in France or Spain within the native range. Density of *G. monspessulana* stands, seedbank density and maximum age of plants were lower in its native Mediterranean habitats than in South Australia. Seed production reached a maximum in plants at about 7 years old in with habitats. There were no significant differences in seed production by plants of equivalent age between Australian and European populations.

Large, dormant seedbanks of up to 100,000 seeds m\(^{-2}\) enable stands of *G. monspessulana* to persist following removal of mature plants. In experiments conducted to determine the potential reduction of *G. monspessulana* seedbanks using controlled burning, 80–90% of the seedbank was killed or stimulated to germinate by fire. A herbicide treatment, closely following burning (within 6 months) is required to remove the dense flush of germinating seedlings.

South Australian perennial, leguminous shrubs were considerably out-numbered by *G. monspessulana* in the seedbank. In addition, the percent of successful emergence of seeds of native legumes was lower. *Acacia melaleucoxylon*, grown in a replacement series with *G. monspessulana*, was the slower of the two species and less plants survived. In contrast, *Eucalyptus leucoxylon* seedlings, grown with *G. monspessulana*, were able to grow taller than *G. monspessulana*. Several of the *G. monspessulana* shaded by *E. leucoxylon* saplings were dead or dying at the culmination of the experiment. *Microlopha stipoides*, a native grass,
accumulated a similar biomass whether grown in pots with *G. mosspessulana* or without. *M. stipoides* also reduced the proportion of *G. mosspessulana* successfully emerging from the seedbank.

Native seedlings comprised no more than half of the seedbank under mature *G. mosspessulana* stands, and less than 20% at all but one site in South Australia. Heating of the seeds before germination did not significantly influence the emergence of exotic or native seedlings other than *G. mosspessulana*. Revegetation with native plants following removal of *G. mosspessulana* is very important however, other than grasses, no significant reductions in *G. mosspessulana* survival or growth were caused by the native species examined. Therefore, follow-up management after a fire will be required in addition to revegetation.
# Table of Contents

BIOLGY AND MANAGEMENT OF \textit{GENISTA MONSPESULANA} (L.) L.A.S. JOHNSON (MONTPELLIER BROOM) ................................................................. I

## CHAPTER 1. GENERAL INTRODUCTION AND LITERATURE REVIEW

1.1  EFFECTS OF LEGUMES ON INVADED ECOSYSTEMS .............................................. 11
1.2  MANAGEMENT OF WEEDS OF NATURAL ECOSYSTEMS ........................................... 12
1.3  PHYSICAL AND CHEMICAL CONTROL ..................................................................... 14
1.4  BIOLOGICAL CONTROL ......................................................................................... 15
1.5  FIRE ..................................................................................................................... 16
1.6  FIRE CHARACTERISTICS AND BEHAVIOR ........................................................... 16
1.7  FIRE-INDUCED CHANGES IN SOIL ....................................................................... 17
1.8  EFFECTS OF FIRE ON VERTEBRATES ................................................................... 19
1.9  EFFECTS OF FIRE ON INVERTEBRATES .................................................................. 20
1.10 CHARACTERISTICS OF PLANTS ENABLING THEM TO SURVIVE CERTAIN FIRE REGIMES .............................................................. 20
1.11 RESPONSE OF PLANT POPULATIONS TO FIRE ...................................................... 21
1.12 TEMPORAL AND SPATIAL EFFECTS OF FIRE ON PLANT COMMUNITIES ................. 23

### 1.12.1 Temporal patterns ......................................................................................... 23

### 1.12.2 Spatial Patterns ........................................................................................... 25

#### 1.12.2.1 Broad scale ............................................................................................. 25

#### 1.12.2.2 Fine scale ............................................................................................... 26

1.13 USE OF FIRE TO MANAGE WEEDS ................................................................. 27
1.14 COMPETITION ..................................................................................................... 30
1.15 THE NATURE OF COMPETITION ......................................................................... 32
1.16 STUDYING COMPETITION ................................................................................... 33

### 1.17 GENISTA MONSPESULANA

#### 1.17.1 Seed production and dispersal ...................................................................... 37

#### 1.17.2 Seedbank dynamics .................................................................................... 37

#### 1.17.3 Establishment and growth of \textit{G. monspessulana} ....................................... 37

#### 1.17.4 Herbivores .................................................................................................. 38

### 1.18 \textit{CLETHRA SCOPARIA} .................................................................................... 36

#### 1.18.1 Seed production and dispersal ...................................................................... 36

#### 1.18.2 Seedbank dynamics .................................................................................... 39

#### 1.18.3 Establishment and growth of \textit{C. scoparia} ................................................. 40

#### 1.18.4 Herbivores .................................................................................................. 41

#### 1.18.5 Effects of \textit{C. scoparia} in exotic habitats .................................................. 42

### 1.19 USES EUROPEANS .......................................................................................... 43

\textit{ vii}
CHAPTER 2. POPULATION AGE STRUCTURE, SEED PRODUCTION AND SZEEDBANKS OF G. MONSPESIULANA IN ITS NATIVE RANGE AND SOUTH AUSTRALIA

2.1 INTRODUCTION

2.2 STUDY SITES

2.2.1 Australia

2.2.1.1 Deep Creek

2.2.1.2 Benoona

2.2.1.3 Lenwood

2.2.1.4 Upper Sturt

2.2.1.5 Willunga Hill

2.2.2 Europe

2.2.2.1 Cote - Site 1

2.2.2.2 Cote - Site 2

2.2.2.3 Font Joseph

2.2.2.4 Farca Real (Chapelle de Notre Dame)

2.2.2.5 Grauloup

2.2.2.6 Lintel de Vid

2.3 MATERIALS & METHODS

2.3.1 Estimation of G. monspessulana age

2.3.2 Seedbank

2.3.3 Seed Production

2.3.4 Seed rain

2.3.5 Obtaining plant samples for determination of age and seed production

2.3.6 Data analysis

2.4 RESULTS

2.4.1 Seed Production

2.4.2 Densities of G. monspessulana in its native and exotic ranges

2.4.3 Seed Rain

2.4.4 Seed Production

2.4.5 Age Structure

2.5 DISCUSSION

2.5.1 Seed production

2.5.2 Seedbanks

2.5.3 Density and age structure
CHAPTER 3. INTERACTIONS BETWEEN G. MONSPESULANA AND A NUMBER OF AUSTRALIAN SPECIES OF EUCALYPTS, LEGUMES AND GRASSES

3.1 INTRODUCTION ........................................................................................................... 64
3.1.1 Choice of experimental design ........................................................................... 64
3.1.2 Choice of plants for competition experiments with G. monspessulana .............. 65
3.2 MATERIALS & METHODS ........................................................................................ 65
3.2.1 Competition for water between a dominant overseas species, Eucalyptus obliqua and G. monspessulana ................................................................. 65
3.2.2 Competition and comparative growth of two perennial legumes, G. monspessulana and Acacia melanoxylon in the field ......................................................... 66
3.2.3 Competition between G. monspessulana, Eucalyptus leucoxylon, Acacia pycnantha and Thymus triandra in a raised soil bed ...................................................... 67
3.2.4 Competition between Eucalyptus obliqua, Microlepis stipoides and Vulpinaria diplodoides and G. monspessulana in pot ............................................................. 68
3.3 RESULTS ...................................................................................................................... 70
3.4 DISCUSSION ............................................................................................................... 71
3.5 CONCLUSION .............................................................................................................. 79

CHAPTER 4. SEEDBANKS OF NATIVE AND INTRODUCED SPECIES UNDER G. MONSPESULANA INFESTATIONS ............................................................. 81

4.1 INTRODUCTION .......................................................................................................... 81
4.2 MATERIALS & METHODS ........................................................................................ 83
4.2.1 Preparation and treatment of the soil ................................................................. 83
4.2.2 Detection and identification of emerging seedlings ............................................ 83
4.2.3 Data Analysis ....................................................................................................... 84
4.3 RESULTS ..................................................................................................................... 84
4.4 DISCUSSION .............................................................................................................. 87
4.5 CONCLUSION .............................................................................................................. 89

CHAPTER 5. USE OF FIRE FOR THE REDUCTION OF G. MONSPESULANA SEEDBANKS ........................................................................................................ 90

5.1 INTRODUCTION .......................................................................................................... 90
5.2 STUDY SITES .............................................................................................................. 90
5.2.1 Bealair .................................................................................................................. 90
5.2.2 Crafers ............................................................................................................... 91
5.2.4 Marble Hill ......................................................................................................... 91
5.2.5 Roseworthy ........................................................................................................ 92
5.3 MATERIALS AND METHODS ................................................................................... 92
5.3.1 Collection and treatment of soil cores to estimate seedbank density ................. 92
5.2 Determination of fuel load

5.3.1 Datalogger, thermocouples and temperature sensors

5.3.4 Gravimetric water content of soil samples

5.3.5 Comparison of the effects of different management strategies, slashing & fire, fire
and herbicide on G. monspessulana

5.3.6 Comparison of response to post-fire herbicide treatments in areas heavily or lightly
infested with C. scoparius and G. monspessulana

5.3.7 Determination of the effect of fuel load on soil temperature and subsequent
germination of native and exotic species

5.3.8 Estimation of the proportion of seedbank germinating versus seed death following
burning at Marble Hill

5.3.9 Investigation of the relationship between soil temperature during a fire and
seedbank reduction due to germination and death at Belair

5.4 RESULTS

5.4.1 Comparison of the effects of different management strategies, slashing & fire, fire
and herbicide on G. monspessulana

5.4.2 Comparison of response to post-fire herbicide treatments in areas heavily or lightly
infested with C. scoparius and G. monspessulana

5.4.3 Determination of the effect of fuel load on soil temperature and subsequent
germination of a selection of native and exotic species

5.4.4 Estimation of the proportion of seedbank germinating versus seed death following
burning at Marble Hill

5.4.5 Investigation of the relationship between soil temperature during a fire and
seedbank reduction due to germination and death at Belair

5.4.7 Determination of optimum temperatures required to break dormancy, with or
without smoke derived chemicals, of G. monspessulana and five native species

5.5 DISCUSSION

5.5.1 Reduction of the G. monspessulana seedbank

5.5.2 Minimizing bioactive impacts on native species

5.5.3 Fire and experimental design

5.6 CONCLUSIONS

CHAPTER 6. GENERAL DISCUSSION

6.1 BIOLOGY AND MANAGEMENT OF G. MONSPESULANA

6.2 RESEARCH DIRECTIONS

6.3 SUMMARY

REFERENCES