Project developed between Universitat Autònoma de Barcelona and University of Western Australia

INFLUENCE OF EMERGENCE TIMING OF WEEDS ON THE ESTABLISHMENT OF WOODY NATIVES AND GROUND COVER SPECIES

Paula Buenaventura Martínez

September 2012 - September 2013

CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1. INTRODUCTION

1.1 State of the art

Probably the best research work to compare this project with is Stevens, J.M. and Fehmi, J.S. (2011) where the early establishment of native grass in Arizona that reduces the competitive effect of a non-native grass (Buffelgrass) is studied.

Buffelgrass was tested against Arizona cottontop in pairwise combinations: three neighbour identities (self, other, and no neighbour), and three competition treatments (21-day younger neighbour, 21-day older neighbour, and same-aged neighbour). When compared with control plants, there was no significant effect on aboveground biomass for older Arizona cottontop plants competing with younger buffelgrass plants. However, when Arizona cottontop plants were of the same age or younger than buffelgrass plants, buffelgrass caused 95 and 88% reductions, respectively, in aboveground biomass in both cases). Intraspecific competition between same-aged Arizona cottontop plants resulted in only 55% decline in aboveground biomass production, thus interspecific competition with buffelgrass was more intense than intraspecific competition for Arizona cottontop when plants had similar emergence times.

These results suggest that establishing native plants immediately following a disturbance event could be a practical technique for restoring or retaining diversity on sites with high potential for invasion by buffelgrass.

Also, at Jurado, E. and Westoby, M. (1999) the relationship between the size of the seed and the growth rate and the biomass was analysed. Their results were that the bigger the seed is, the lower the growth rate and the higher the biomass will be. As presented below, the lineal regression method is not accurate enough for a short term growth rate.

1.2 Justification

Figure 1. Project justification

The Australian Government states that climate change is a challenge for all sectors of the Australian economy but particularly for those sectors dependent on natural resources, like agriculture and forestry. The Climate Change Division of the Department of Agriculture Fisheries and Forestry manages Australian Government policies and programs to help primary industries and producers make choices and decisions to adapt and respond to climate change.

The Climate Change Research Program, a component of Australia's Farming Future, ended on 30 June 2012. The program funded research projects and on farm demonstrations to help prepare Australia's primary industries for climate change and build the resilience of our agricultural sector into the future. Research focused on reducing greenhouse emissions, improving soil management and climate change adaptation.

Between 2008–09 and 2011–12 the Australian Government invested $46.2 million to support over 50 large scale collaborative research, development and demonstration projects. These projects were delivered in partnership with research providers, industry groups, universities and state governments. Total investment under the program, including partner contributions, was over $130 million. A breakdown of the allocated government funding is below:

- Reducing Emissions from Livestock Research Program–$11.3 million
- Nitrous Oxide Research Program–$4.7 million
- Soil Carbon Research Program–$9.6 million
- National Biochar Initiative–$1.4 million
- Adaptation Research Program–$11.5 million
- Demonstration on–farm or by food processors–$7.7 million.

Within the scope of work of the Reducing Emissions from Livestock Research Program it is planned the study named University Western Australia (UWA) "Future Farm" Ridgefield: On-farm methane management strategies. The project here developed is part of the study mentioned above and followed up by the UWA.

1.3 Purpose

The investigation described in this report is a part of a larger investigation carried out by the School of Plant Biology of the University of Western Australia, aiming to find the influence timing of weeds on the establishment of woody natives and ground cover species.

Through a field experiment, an exploration of the competition between woody native species and a native grass (*Austrodanthonia caespitosa*) and how this interaction might change with different emergence timing of a weed community will be carried out. The purpose of this trial is to define the nature of interaction between three different functional types of species, trying to follow the next questions as the project shaft.

1. How does the late emergence of the weed community affect the establishment of five woody natives and one native grass?
2. Does the late emergence of weeds affect their abundance under competition with woody natives and ground cover species?
3. How do woody natives and native ground covers species affect the establishment of each other?
4. How does the late emergence of weeds affect the interaction between woody natives and ground cover species?

1.4 Scope

In this project a field experiment would be set up to achieve the scope of the main research question. The target species are subject to more realistic conditions like longer time of competition against a whole community of invasive species and stressors like water scarcity and high radiation. With this field experiment it's also intended to describe possible differences between target species when they grow as monocultures and their growth when they are mixed with a native grass *Austrodanthonia caespitosa* (Wallaby grass). This interaction also will be examined under presence of a weed community in order to identify the nature of interaction between these three components.

Using field data were obtained during the stay in Ridgefield, the study allows to conduct a trend analysis of growth towards the weed, wed after and no weed treatments. There is no more data to make statistical inferences more specific and comprehensive and therefore, the work is based on performing the analysis of growth trends in different plant varieties.

This project will focus on:

- Collaboration in the design phase of several experimental projects in Ridgefield.
- Collection of field data.
- Statistical analysis of experimental data field.
- Indicate the different patterns of growth of seedlings in function of the treatments performed.
    - Regression models
    - Perish rate method
- Analyse the survival of plant species depending on the treatment performed
- Analyse factors that influence the growth rates and survival

CHAPTER 2. BACKGROUND

2.1 Australia's Native Grasslands

When European settlers first arrived in Australia, much of the continent was covered by grasslands (a mixture of grasses, bulbs, lilies, daisies, hardy ferns and small shrubs with pea flowers; there are few or no trees) and grassy woodlands (have scattered mature trees as well as younger trees ‘in waiting’; will have a selection of scattered larger shrubs). Many of the explorers referred to grasses as the dominant plants in the landscape. They glowingly reported the richness of the countryside.

For thousands of years, the grasslands and grassy woodlands had been periodically burned, either as the result of lightning strikes, or by the firestick farming of native Australians. As a result, shrub and tree growth was suppressed, and grasses -mostly tussocky, persistent perennials- flourished.

Since then, altered land-management - land-clearing for European-style cropping, intensive grazing and the introduction of ‘improved’ pastures, and the suppression of fire - has changed these grasslands. Now, less than 1% of the original temperate grasslands and grassy woodlands remain intact.

2.2 Role of the Native Grasslands and Grassy Woodlands

Grasslands are complex systems. Above ground, they support diverse and interdependent plant, insect, bird and animal communities. Underground, vital soil organisms such as earthworms enhance the infiltration of water. As these animals and plants break down, they add to the soil's fertility. Plants also protect the soil surface from erosion.

Across Australia, large areas of our best farming land are being made unusable by increasing soil salinity and acidification. If we want to be able to rehabilitate our degraded soils and water courses, we need to learn much more about our grassland communities. In addition, in a world where climate change is highly likely, grasses - which are very adaptable plants - are bound to have an important role in future land management.

2.3 Emplacement contextualization

Since the early 1960s, the University of Western Australia (UWA) has owned a farm, Allandale, on Great Eastern Highway near Wundowie. Around 1980, the Animal Science discipline in the then Faculty of Agriculture took responsibility for the property and, mostly through volunteer labor by staff and students, developed it as a research resource.

Over the past 25 years, Allandale has played a major role in teaching and research. Expanding research and development needs led to the acquisition of a 1588 ha farming property at West Pingelly. UWA Ridgefield is located 25 km north-west of Pingelly, about 158km south-east of Perth, on the western edge of the Central Grainbelt. It was selected for a number of reasons like soil types, location, topography, rainfall, total area and the overall excellent condition of the property. It is ideal for development as a resource to facilitate state, national and international research with inputs from the local and WA farming community, re-affirming the long-term commitment of UWA to agricultural research and development.

2.4 Land use history

2.4.1Previous uses

Prior land use history may affect the delivery of ecosystem services (PROBER and SMITH, 2009; MAESTRE et al., 2012). The landscape around Ridgefield is highly fragmented due to vegetation clearing that occurred from the 1830s on the more fertile soils, and with increasing rapidity across the whole 14 million hectares of the wheatbelt following the end of the Second World War (PROBER and SMITH, 2009) .The 21 ha experimental site was dominated by two prior agricultural land uses, pasture for sheep (hereafter 'grazed'), and a smaller cropped area most recently planted with canola (Brassica napus, oil seed rape) in a 3-to-1 rotation (3 years crops, 1 year fallow/grazed) (YATES et al., 2000). It is likely that the area was cropped with wheat (Triticum spp.) in the past.

Cropping often leads to a legacy of high soil P availability (BARROW, 1980; SHARPLEY et al., 2004; STANDISH et al., 2006). This legacy has differential consequences for native flora: increasing soil P can be toxic to proteaceous species (SHANE and LAMBERS, 2006) but can increase the growth of myrtaceous species (STONEMAN et al., 1995). High soil P can also increase the competitive ability of non-native species on old-fields (STANDISH et al., 2008).

The previously cropped and grazed areas of the site therefore provide us with the ability to investigate how ecosystem service delivery, and any restoration trajectory, is influenced by land use history.

2.4.2 Afterwards

Today, land use continues to be based on dryland agricultural production using annual, winter growing, pastures and crops. Livestock production is dominated by wool production with trade in sheep for meat increasing in importance. The types of crops and rotations are greatly influenced by soil types and rainfall.

The main pastures are annual pastures based on subterranean clover often mixed with annual grasses such as rye grass and broad-leaved species such as capeweed. Annual medics occupy a niche on some alkaline soils. The length of pasture phases range from longer-term pastures of 4 to 5 years to year in year out crop/pasture and continuous cropping. There is an increasing trend towards multiple cropping alternating with pasture phases. Recently, alternative pasture species have been introduced into specific environmental niches. Balansa clover is often mixed with perennial grasses on waterlogged and slightly saline land and serradella grows well on well drained sandy surfaced soils. Some Landholders are incorporating lucerne as a perennial pasture phase to increase water use, help reduce groundwater recharge and increase soil fertility. Although sheep numbers declined during most of the 1990s, they remain a part of the rotation on many farms.

Cereals (wheat, barley, oats, and hay) remain the main crops within the rotation. Canola on a wide range of soils, and lupins on sandier, acid soils, are widely grown to break disease cycles and reduce herbicide resistance. Small areas of faba beans, field peas ,chickpeas, and lentils are grown as break crops on neutral to alkaline soils.

Over the past decade, farmers have become more aware of land conservation issues, particularly increasing salinity. There is increasing interest in re-establishing perennials but options for commercial species are relatively limited due to low rainfall. Options include oil mallees in belts and saltbush species on salt-affected land. Research continues into farming systems that include perennials. Sandalwood (*Santalum spicatum*) and maritime pine (*Pinus pinaster*) show some promise.

2.5 Ridgefield geology and geomorphology

Ridgefield bellows to Pingelly region. The characterization of the geology and geomorphology it's explained in the next section.

2.5.1 Geology

The Pingelly System is largely stripped of laterite, with isolated, prominent mesas remaining throughout the landscape, most commonly on sub-catchment divides. These mesas contain duricrust and shallow gravel soil vegetated by Powderbark wandoo (*Eucalyptus accedens*) and Parrotbush (*Dryandra species*). Scarp slopes are covered by water-repellent loamy duplex soils (mallet soil) vegetated by mallet. A few larger plateau remnants remain and these display the range of lateritic soil that exists on similar landforms further west.

Granite outcrops are common in the Pingelly System and, together with associated 'fresh' granitic soil, become dominant on stripped sub-catchment and catchment divides. The soils are generally granitic sandy (Rock-Sheoak Sand) and loamy earths (York Gum/Jam Soil) under York gum (*E. loxophleba*) and jam (*Acacia acuminata*) and occasionally rock sheoak (*Allocasuarina heugeliana*) vegetation. Iron in these soils differentiates rapidly under this vegetation and sandy duplexes (Wandoo/Sheoak Sandy Duplex) with ironstone gravels and 'younger' lateritic soil form in areas most removed from fresh sources of phosphorus.

Small areas of the Pingelly System have been identified as having aeolian (windblown) sands that appear to have been blown in from ephemeral fresh lakes or saline areas in adjacent valleys. These deposits are dominated by pale and yellow sandy soil and are vegetated by *Banksia* and *Allocasuarina* tree species.

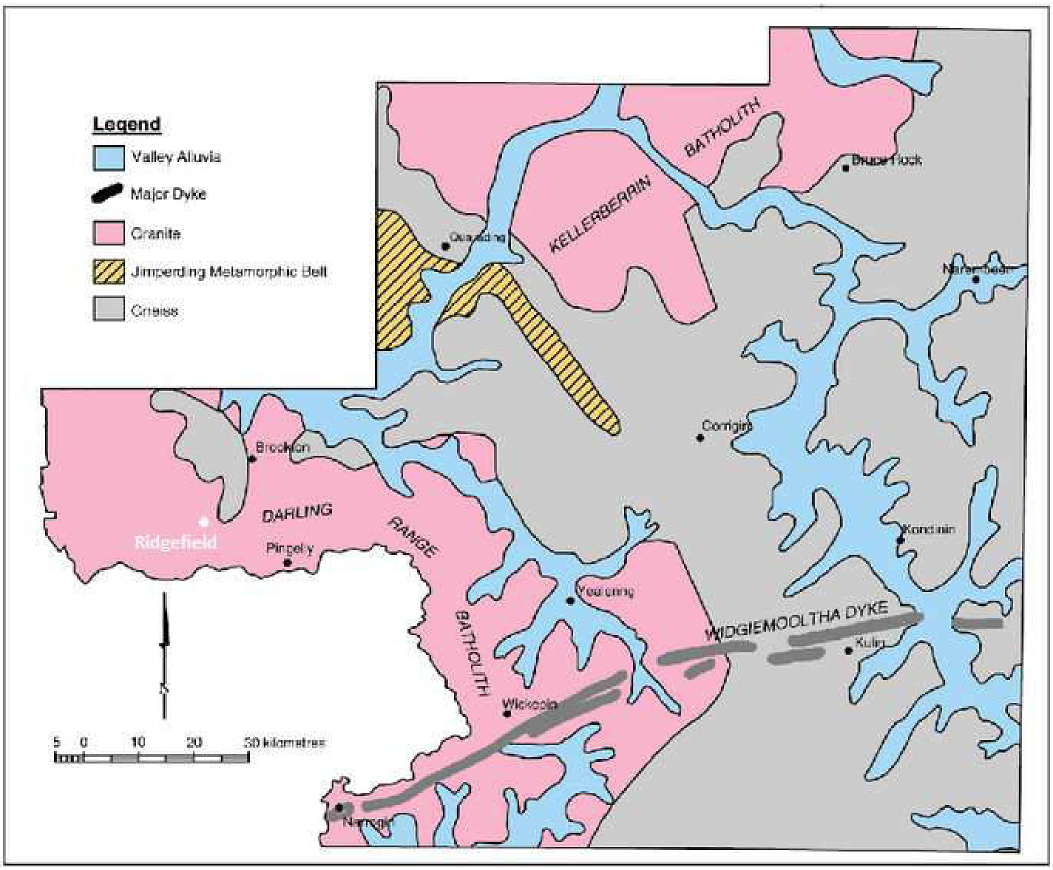


Figure 2. Geology map of Pingelly region

2.5.2 Geomorphology

In this section the soil types characterization present in the study area will be explained. The segment referred to geology indicated that the type of soil that is found in granitic origin, namely a mixture of sand bags with gravel clay matrix.

Once viewed soil map of Pingelly region, which has been identified in terms of Ridgefield, expected range of undifferentiated upland soils in the Zone of Rejuvenated Drainage, usually hill slope duplexes developed in colluvium.

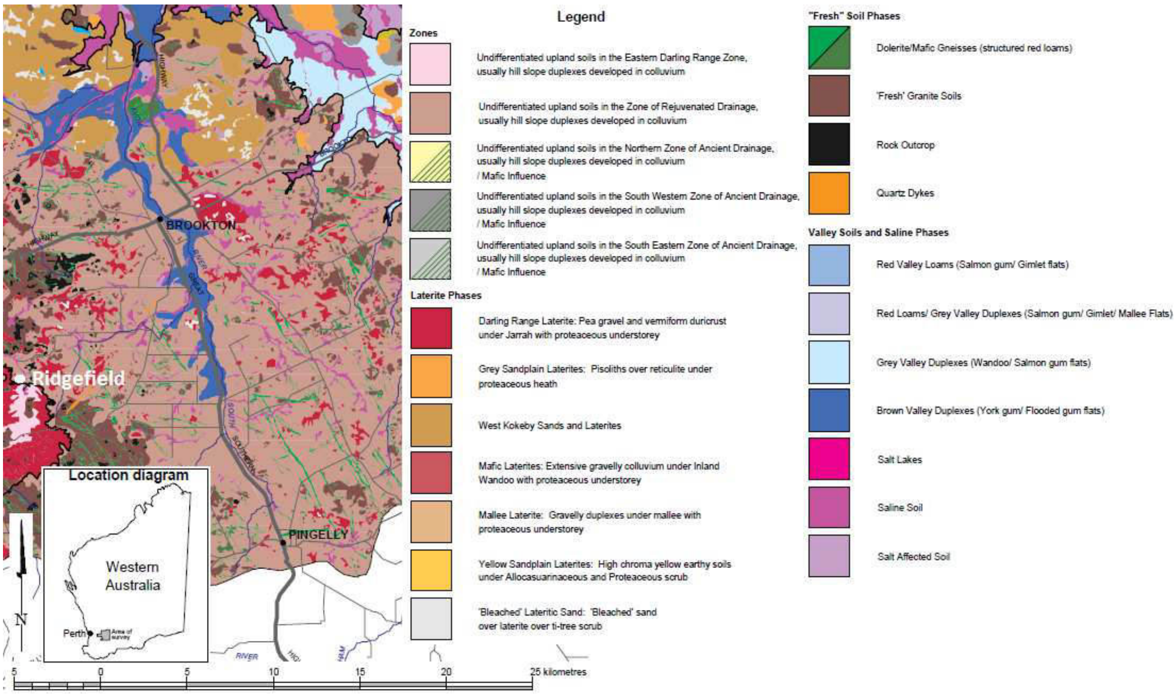


Figure 3. Soils map of Pingelly region

2.6 Ridgefield climatology

The Ridgefield climate could be described with the climate of the Pingelly region. As it's reflected in the next charts, this area has from a dry to extra dry Mediterranean climate with hot dry summers and cool wet winters. Average annual rainfall increases from 325 mm in the north east to 600mm in the west. It falls mainly in the winter months during the passage of cold fronts. Summer storms are infrequent but may be intense and can cause significant erosion and agronomic problems.

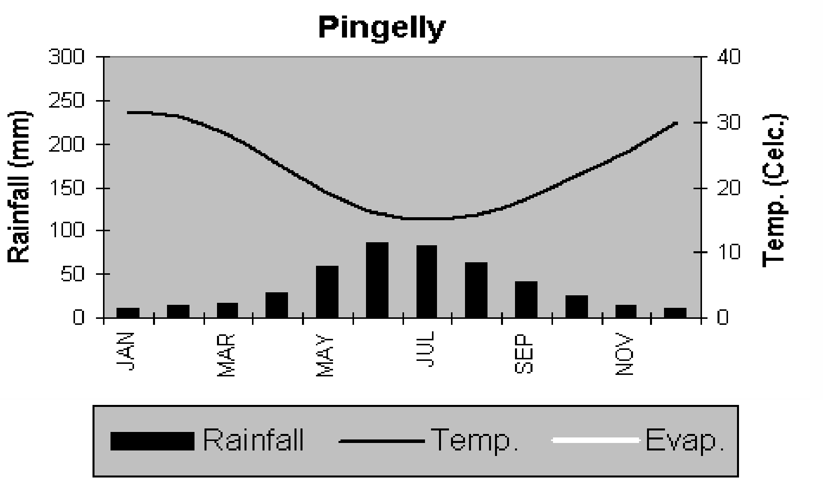


Figure 4. Annual average rainfall isohyets and weather recording stations in and around the Corrigin Survey area with (below) monthly temperature, rainfall and evaporation for five selected stations.

CHAPTER 3. METHODOLOGY

This section aims to show the different necessary bases in order to enable the different tests carried out in this work. There will be a description of the different plant varieties analysed, as well as the management indicated the experimental plots, indicating the different tools and methods used in carrying out different jobs, including the working planning in time.

3.1 Species conceptualization

Some of the most characteristic species of flora are Australian acacias and eucalyptus. That is why this experiment has used this species as an object of study. Specifically, it's been used: *Eucalyptus accedens, Eucalyptus astringens, Eucalyptus loxophleba*, *Acacia acuminata*, *Acacia pulchella*, *Acacia sessilis* and native grass *Austrodonthonia caespitosa*. Woody species were selected based on their characteristics for the acquisition of nutrients and the size of the seed. The eucalyptus naturally associated with arbuscular mycorrhizal and ectomicorrizas while Acacias are mostly nitrogen fixers.

In addition to the characteristics of nutrient acquisition, species were selected to have broad distribution in the study area, high germination rate and seed availability through local suppliers (Nindethana Seed Service, Albany, Western Australia).

3.2 Vegetation species. Types and general traits

A characterization of the main features employed for the selection of the varieties used in the study it's done in the next section followed by an explanation of the different species that have been used in the study.

In a second term there will be developed the discussed issues relating to the management of the experimental plots.

3.2.1 Nutrient acquisition forms

Fungus symbiosis. Eucalyptus relationship

In the first section of chapter 3, was explained that woody species were selected based on their characteristics for the acquisition of nutrients. Eucalyptus is associated with arbuscular mycorrhizal and ectomycorrhizal, while Acacias are mostly nitrogen fixers.

The mycorrhiza is a symbiotic (generally mutualistic, but occasionally weakly pathogenic) association between a fungus and the roots of a vascular plant (have specialized tissues to conduct water). In a mycorrhizal association, the fungus colonizes the host plant's roots, either intracellularly as in arbuscular mycorrhizal fungi, or extracellularly as in ectomycorrhizal fungi. They are an important component of soil life and soil chemistry.

This mutualistic association provides the fungus with relatively constant and direct access to carbohydrates, such as glucose and sucrose. The carbohydrates are translocated from their source (usually leaves) to root tissue and on to the plant's fungal partners. In return, the plant gains the benefits of the myceliums (the vegetative part of a fungus) higher absorptive capacity for water and mineral nutrients due to the comparatively large surface area of mycelium: root ratio, thus improving the plant's mineral absorption capabilities.

Plant roots alone may be incapable of taking up phosphate ions that are demineralized in soils with a basic pH. The mycelium of the mycorrhizal fungus can, however, access these phosphorus sources, and make them available to the plants they colonize.

The mechanisms of increased absorption are both physical and chemical. Mycorrhizal mycelia are much smaller in diameter than the smallest root, and thus can explore a greater volume of soil, providing a larger surface area for absorption. Also, the cell membrane chemistry of fungi is different from that of plants (including organic acid excretion which aids in ion displacement). Mycorrhizas are especially beneficial for the plant partner in nutrient-poor soils.

Mycorrhizal plants are often more resistant to diseases, such as those caused by microbial soil-borne pathogens, and are also more resistant to the effects of drought. Fungi have been found to have a protective role for plants rooted in soils with high metal concentrations, such as acidic and contaminated soils.

Plants grown in sterile soils and growth media often perform poorly without the addition of spores or hyphae of mycorrhizal fungi (is a long, branching filamentous structure of a fungus and are collectively called a mycelium) to colonise the plant roots and aid in the uptake of soil mineral nutrients. The absence of mycorrhizal fungi can also slow plant growth in early succession or on degraded landscapes. The introduction of alien mycorrhizal plants to nutrient-deficient ecosystems puts indigenous non-mycorrhizal plants at a competitive disadvantage.

Mycorrhizas are commonly divided into ectomycorrhizas and endomycorrhizas. The two types are differentiated by the fact that the hyphae of ectomycorrhizal fungi do not penetrate individual cells within the root, while the hyphae of endomycorrhizal fungi penetrate the cell wall and invaginate the cell membrane.

Endomycorrhizas are variable and have been further classified as arbuscular, ericoid, arbutoid, monotropoid, and orchid mycorrhizas. Arbuscular mycorrhizas (formerly known as vesicular-arbuscular mycorrhizas or AM) are mycorrhizas whose hyphae enter into the plant cells, producing structures that are either balloon-like (vesicles) or dichotomously branching invaginations (arbuscules) and help plants to capture nutrients such as phosphorus, sulfur, nitrogen and micronutrients from the soil.

The fungal hyphae do not in fact penetrate the protoplast (i.e. the interior of the cell), but invaginate the cell membrane.

Arbuscular mycorrhizas are found in 85% of all plant families, and occur in many crop species. The hyphae of arbuscular mycorrhizal fungi produce the glycoprotein glomalin, which may be one of the major stores of carbon in the soil.

Ectomycorrhizas (EcM) are typically formed between the roots of around 10% of plant families, mostly woody plants including the birch, dipterocarp, eucalyptus, oak, pine, and rose families, orchids, etc.

Unlike other mycorrhizal relationships, ectomycorrhizal fungi do not penetrate their host's cell walls. Instead, they form an entirely intercellular interface, consisting of highly branched hyphae forming a latticework between epidermal and cortical root cells, known as the Hartig net.

This hyphal network aids in water and nutrient uptake often helping the host plant to survive adverse conditions, and in exchange, the fungal symbiont is provided with access to carbohydrates.

Mycorrhizas have been regarded as the most prevalent symbiotic condition on earth, and as such they are essential to plant nutrition in terrestrial ecosystems. Thus, even alien plants often require mycorrhizal symbionts for the establishment and spread into foreign environments.

Due to the low specificity of the vast majority of arbuscular mycorrhizas, AM plants often become invasive quickly and easily, and as such, the invasions are not necessarily accompanied by a simultaneous AM fungal invasion. However, because ectomycorrhizal symbioses present a range of specificities, exotic forestry has often relied upon the introduction of compatible EcM fungi to the foreign landscape in order to ensure the success of forest plantations and the like.

This is most common in eucalypts and pines, which are obligate ectomycorrhizal trees in natural conditions. This is evidenced by the struggle of establishment of pines in the southern hemisphere until the anthropogenic build-up of soil inoculums. Similarly, Australian eucalypts and acacias have evolved in isolation from the EcM fungi associated with many other temperate trees such as Pinus and Quercus. Thus, much like pines in the southern hemisphere, many Eucalyptus plantations required inoculation by EcM fungi from their native landscape. In both cases, EcM networks allowed for the naturalization of the introduced species, followed quickly by competition for resources with native plants and invasion into novel habitats.

Nitrogen fixation. Acacia relationship

Instead of that, Acacias are mostly nitrogen fixers (legumes and actinorrizas) which establish a symbiotic association with nitrogen-fixing soil microorganisms of Rhizobium and Frankia genera respectively. These trees can also form symbiosis with mycorrhizal fungi. These partnerships allow the fixation of atmospheric nitrogen and improve water absorption and assimilation of nutrients. In many disturbed sites, nitrogen fixing trees can grow better than non-fixers and even better than herbaceous plants fix nitrogen. These trees are nitrogen-fixing species tolerant to different types of stress typical of degraded soils, such as salinity, acidity, heavy metals, drought, fire, invasive weeds, nutrient deficiencies, flooding, compaction and crusting. These trees are able to recycle large amounts of organic matter and nutrients through litter decomposition, and although other forms of management of degraded lands may also be important, those are a good alternative for soil remediation.

3.2.2 The role of the seed size

Related with the seed size is assumed that the influence of the amount of food reserves may have on seedling establishment is particularly important (SALISBURY, 1942; GXIME and JEFFREY, 1965; SILVERTOWN, 1981; ATKINSON, 1972). Generally it's been found that species with larger seeds tend to have relative growth rates slower (FENNER, 1978; PETERS SHIPLEY, 1990). In other words, the surplus resources available in larger seeds are not completely converted to an advantage of size of seedlings, at a certain time after germination.

In the literature it's been considered two main patterns seed size. The larger seeded species tend to be found (i) in environments where seedlings are established in shadow, and (ii) in environments where seedlings are particularly susceptible to drought.

As SALISBURY (1942) and BAKER (1972) suggested, larger food reserves may allow seedlings to establish a larger root system, soon, with greater chance of surviving the drought. One difficulty with this argument is that the ability of a root system to acquire water must be considered in relation to the evaporative demand of the stem, so it is not clear that a larger root system represents an advantage if the stem is too big. Accordingly BAKER (1972), following the suggestion of STEBBINS (1971) suggested that species in arid environments with larger seeds might be able to change the distribution root/shoot more in favour of the root-seeded than species with small seeds during seedling establishment.

Species	Seed size (mg)
Acacia sessilis	2.04
Acacia pulchella	7.36
Acacia acuminata	17.07
Austrodanthonia caespitosa	0.41

Species	Seed size (mg)
Eucalyptus accedens	0.16
Eucalyptus astringens	0.55
Eucalyptus loxophleba	0.61

Table 1. Seed size of the studied species and approximate number of seeds planted in each plot.

Figure 5. Species seeds: *1- Eucalyptus accedens, 2- Eucalyptus astringens, 3- Eucalyptus loxophleba, 4- Acacia sessilis, 5- Acacia pulchella, 6- Acacia acuminata, 7- Austrodanthonia caespitosa.*

3.2.3 Varieties studied

As mentioned in the introduction, eucalyptus and acacias are the species that have been selected. Below there is a description of the main features.

Eucalyptus accedens

Known as Powderbark wandoo, is a eucalypt native to Western Australia. A medium sized tree up to 20-25 m in height, with relatively large branches reaching 1/4 to 1/3 of the tree height. The crown is heavily branched. The smooth bark is notable for being covered in a talc-like powder. It is pale-white when fresh. The white flowers occur in autumn. Produce a good, dark red, very heavy, hard, strong and tough timber. In Australia, the tree occurs naturally within the latitudinal range of 22-33°S and it is mainly found at altitudes between 180-600 m. It occurs on hill tops and gentle to steep slopes and to a lesser extent on flat country.

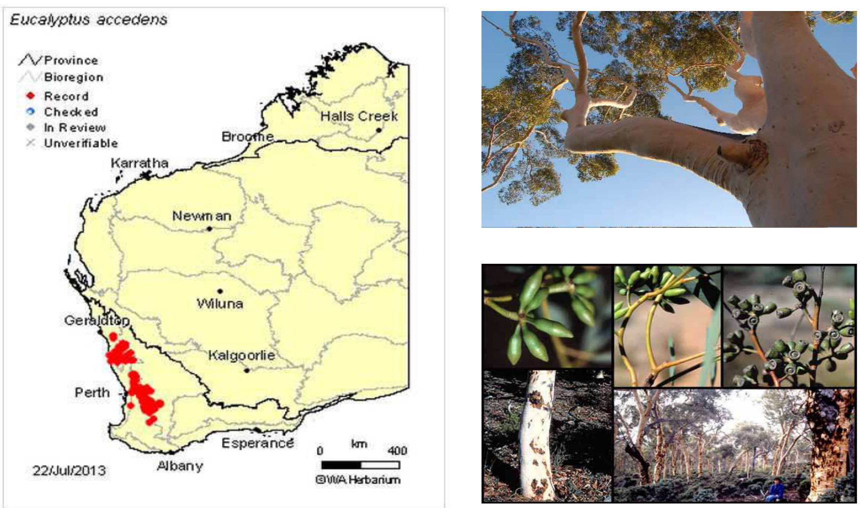


Figure 6. *Eucalyptus accedens*

Eucalyptus astringens

Known as Brown mallet, it's a small to medium sized tree up to 10-25 m in height, with a trunk diameter of up to 70 cm. The trunk is usually straight and up to 1/2 of the tree height. The tree branches steeply. Heartwood light red-brown to dark grey-brown, with reddish streaks, of fine texture and straight or interlocked grain, very hard, strong, very tough and moderately durable. The wood is used for tool handles, mining timber, farm purposes and fuel. The bark has high tannin content (40% or more). In Australia, the tree occurs naturally within the latitudinal range of 31.7-35°S and it is most common at altitudes between 200-350m. The tree occurs on country of low relief and is most commonly found on the sides of low stony hills.

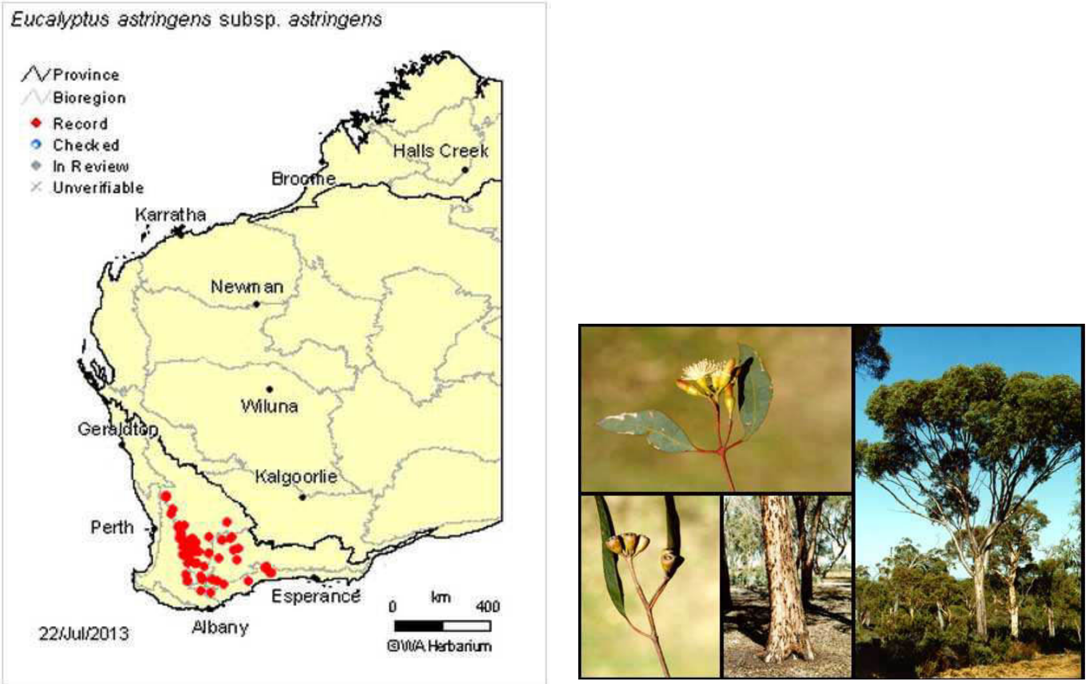


Figure 7. ***Eucalyptus astringens***

Eucalyptus loxophleba

Known as York gum, it's a small to medium sized tree up to 5-15 m in height, with a trunk diameter of up to 60 cm. The species varies from a small handsome tree to a small, straggly shrub. Heartwood yellow-brown, very dense, hard, tough, with closely interlocked grain. The wood is used for shelterbelt or shade for stock, flowers produce nectar for honey production, pollen has value for apiculture, Wildlife value: flowers are especially attractive to birds, craft wood (for turnery etc.), high quality fuel wood, speciality timber for quality furniture wheelwright and similar work. In Australia, the tree occurs naturally within the latitudinal range of 25.5-34.5°S at altitudes between sea level and 350 m. The tree is mainly found on slopes of undulating country.

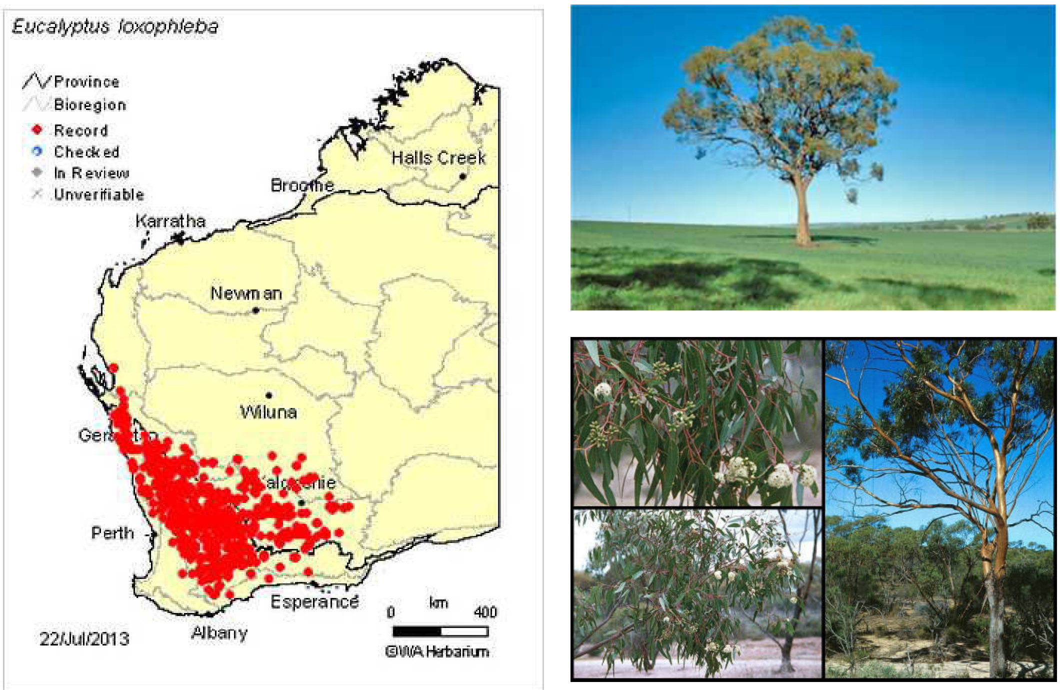


Figure 8. ***Eucalyptus loxophleba***

Acacia sessilis

It's a spreading prickly shrub around 0.3-1.5m high. It blooms yellow flowers from April to September. Grows in sand or lateritic soil (rich in iron and aluminium), in heath, sedgeland or low woodland.

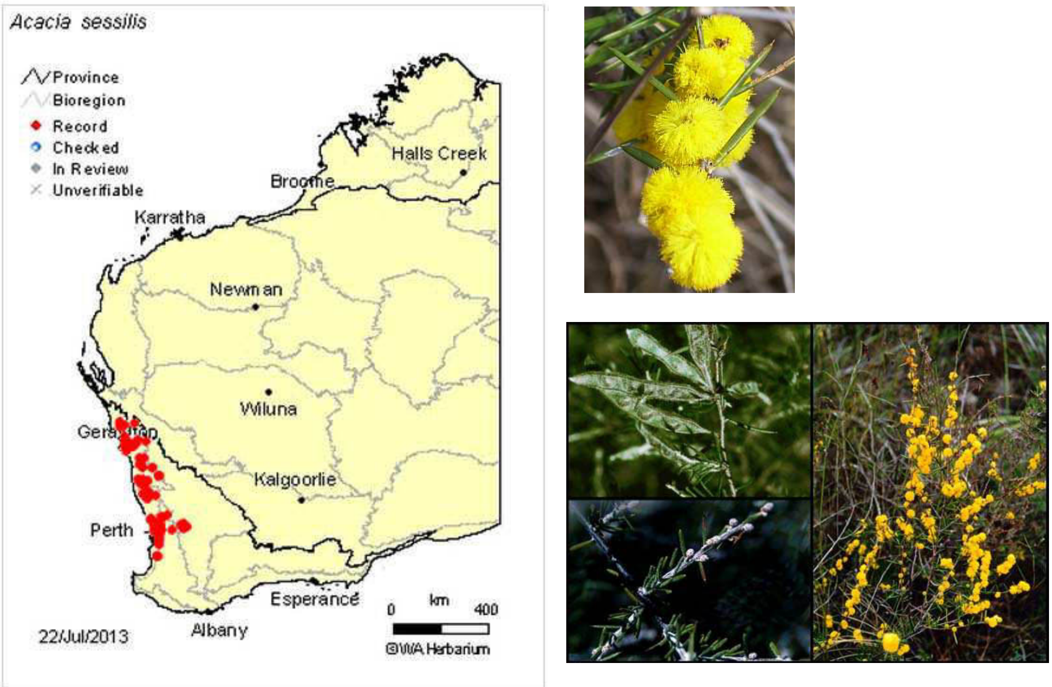


Figure 9. ***Acacia sessilis***

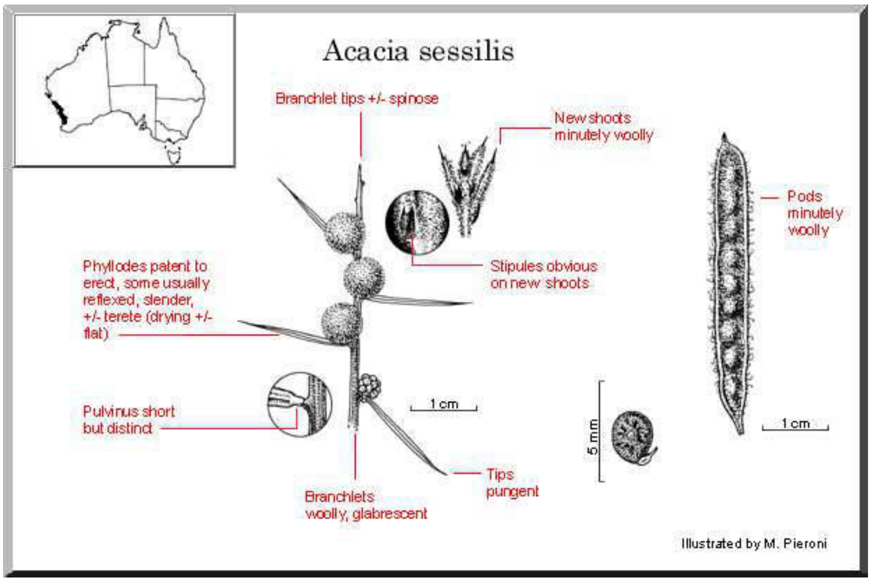


Figure 10. *Acacia sessilis*

Acacia pulchella

Known as Prickly Moses, it's a shrub to 0.3-3 metres tall. The yellow flowers are produced from May to December. It's a common plant in many bushland areas around Perth. It needs well drained light to heavy soil, dappled shade to full sun. Even though it is prickly, it can be used quite successfully to control human foot traffic, and animal access. This is another which can be propagated by seed or cuttings. Watch for new growth following pruning for cutting material. This Acacia is drought hardy and lime tolerant.

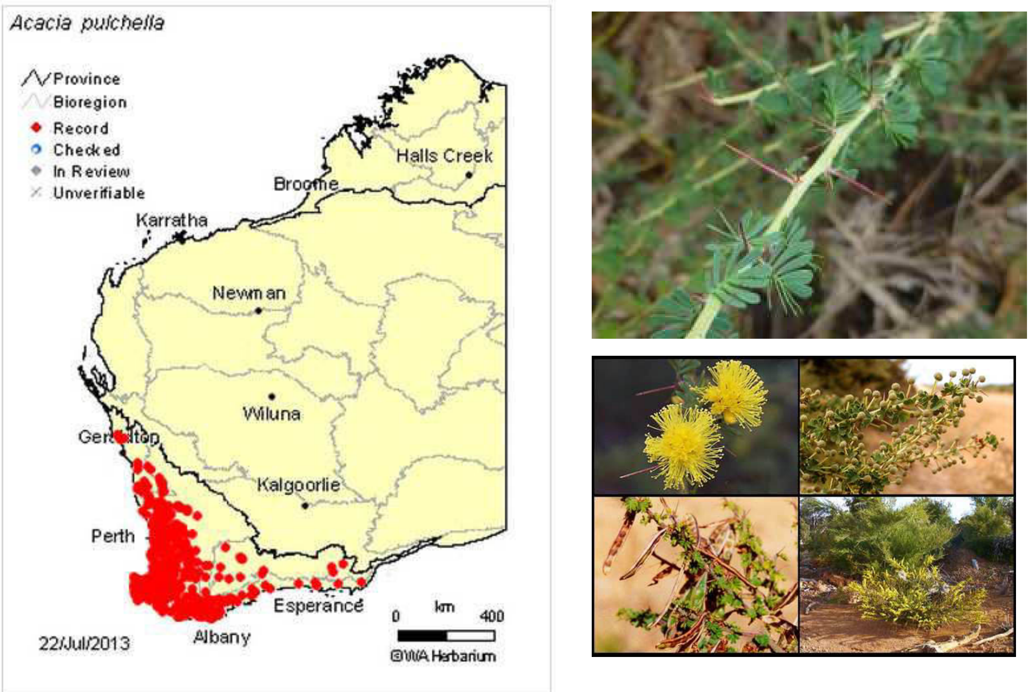


Figure 11 *Acacia pulchella*

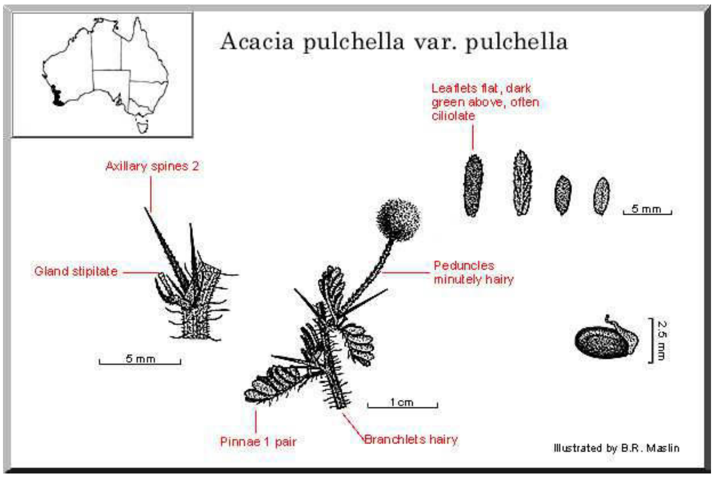


Figure 12. ***Acacia pulchella***

Acacia acuminata

Known as Sandhill Wattle or Raspberry jam, it's usually shrub or small tree 3-5m tall, but on favourable sites it may be a tree up to 10 m tall and grows on a range of gently undulating terrain on soils that range from clays to red sand and granitic gravels. The trunk is 1-2.5 m tall and it divides into numerous fine spreading erect branches. Flowering in this species occurs mainly during late winter to spring and mature pods are present during summer. It's a moderately long-lived but relatively slow growing small tree. It is tolerant of drought and frosts and is moderately salt tolerant. Subsp. *A. acuminata* grows on seasonally dry duplex soils. The wood has a distinct scent of raspberry jam and is very durable in the ground and favoured for round fencing material; it has an attractive grain and is used for craftwood. It is also used for ornamental articles, machine bearings and sheave blocks. Perennial. In Australia, the latitudinal range of the tree is 27-35°S and it occurs at elevations between sea level and 400 m, with the main occurrence between 125-325 m.

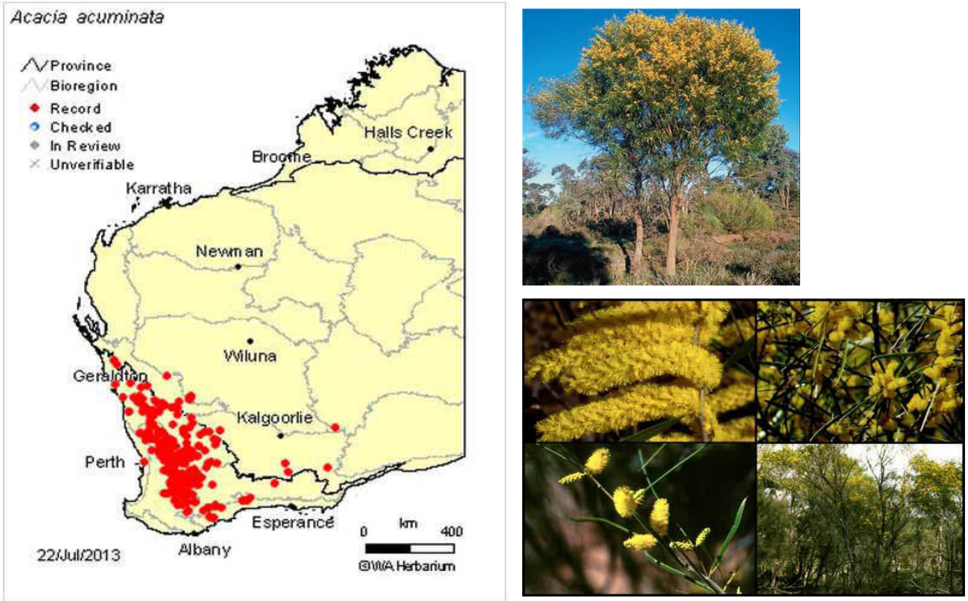


Figure 13. *Acacia acuminata*

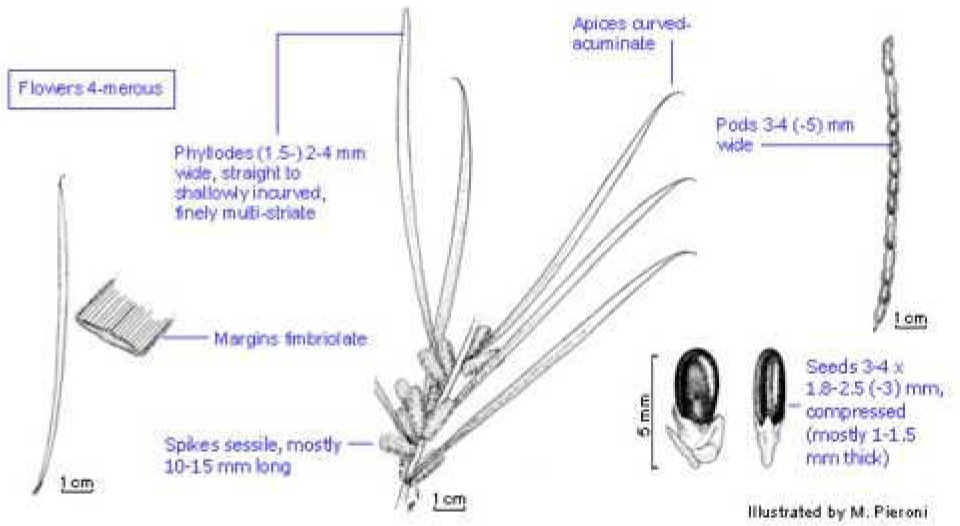


Figure 14. *Acacia acuminata*

Austrodanthonia caespitosa

Known as Wallaby grass, it's a widespread perennial winter grass that occurs throughout temperate Australia, south of 32 degrees latitude, generally restricted to sunny habitats, from grassland to desert to heathlands. It occurs across a wide geographical and environmental range but not abundant in the saline environments. It grows in clay soils as well as on sandy clay loams; it appears to avoid sandy soils.

It flowers in spring and summer or in response to rain. The seed collecting time in WA is in December to January with sowing of seed in autumn. Fruit is dispersed by wind or unintentionally by animals. When propagating, use fresh seed before certain dormancy sets in. After broadcasting fresh seed, *Austrodanthonia* is quick to establish, with good tussock growth within 12 months. If broadcast by hand, from the first autumn rains in March it generally takes 2 years to establish.

It is recognized as a valuable pasture plant for cleared hill country and poorer class land. After flowering, the stems and seedheads dry off to remain standing as hay or roughage of reasonable quality, the leaves remain green unless very dry conditions persist. Wallaby grasses grow well under heavy grazing and will respond to increased fertility though fertiliser application is not needed for persistence. It withstands drought, heavy frosts and increases with increased stocking rates.

Figure 15. ***Austrodonthonia caespitosa***

3.3 Field work distribution

After georeferencing the study area, there is a plot description of how has been handled the different plots. The steps listed in the description of the plots are under the line of the experimental project.

3.3.1 Study site

The experimental plots were established in an isolated area for purposes of ecological restoration and include 21 ha. It's located in an area traditionally known as the "Wheatbelt" in the South West of Western Australia, to 174km from Perth (31 ° 57'11 "E).

In the hole Ridgefield experiment there were two prior land use histories on the site—formerly cropped and formerly grazed (hereafter referred to as 'CRPD' and 'GRZD'). The different plots of this study were located in the grazed area and in the cropped due to its smaller area. All plots, within the land use histories, were blocked on the previous work on the basis of soil type, aspect, and soil moisture, following a rule-based system. These factors were chosen given their likely importance in determining plant growth and thus the responses of the ecosystem services of interest, taking primary account of soil type. Soil types were classified via hand texturing, and thus based on clay content. The range of clay content found at the site was from 5–10% to 40–45%. But the type of soil it's not taken into account in this study.

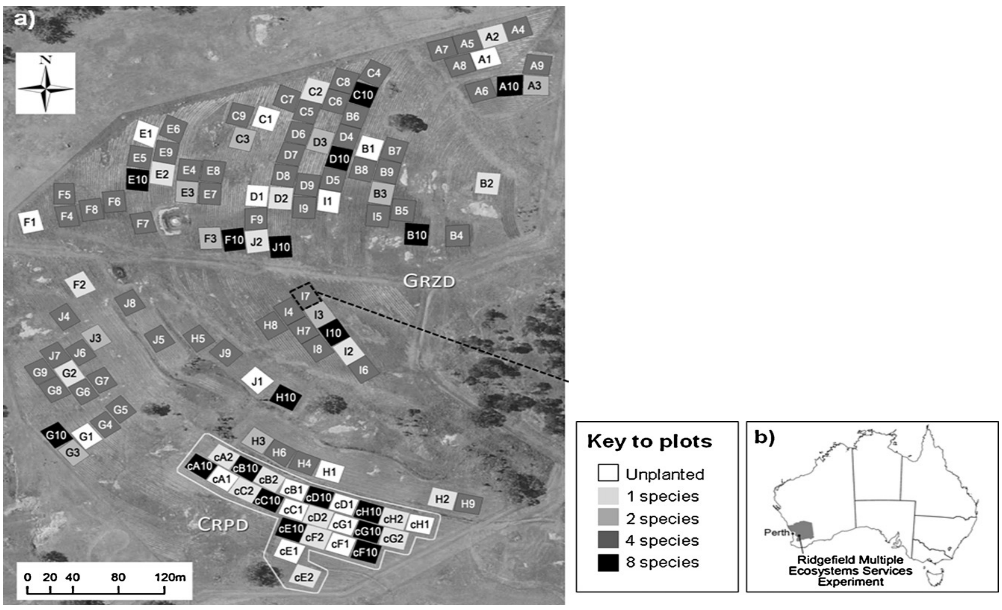


Figure 16. Plot *distribution*

3.3.2 Plots management

To evaluate the interactions between community weeds, grass and native woody species according to the time of emergence of the weed community, a complete block design with 10 replications at random it's established. Each block is made up of three parcels 5 X 2.5m corresponding to three different moments in the emergence of the weed community: 1) natural emergence, 2) delayed emergence and 3) control, without weed. By the time that were sowing the seeds of the species studied, the resident community of weeds in treatment 1 had a height between 10 and 15 cm. The eradication of weeds in treatments 2 and 3 was made by a single spraying glyphosate (diluted commercial 360ml/l) with a fumigator a week before planting the species studied. The concentration used was 1:100 ml of water. Eliminating weeds in controls after spraying was done manually with scissors trimmer to prevent the removal of soil.

Within each plot were located, distributed in two parallel rows of similar size, 14 subplots of 0.3 X 0.3 m, which were sown in three different types according to the composition of seed mixtures 1) monospecific, with woody seeds of each species, 2) monospecific with seeds of *Austrodanthonia* caespitosa, 3) mixed with seeds of each species of woody and *Austrodanthonia caespitosa*. In one of the 14 subplots there was no seed to be used as a control. The location of the mixtures in each sub-parcel was random. The distance between each row of subplots was 0.3m and the distance between rows was 1m. The amount of time used by each species was defined based on the expectation of having a sufficient number of seedlings emerging and survivors throughout the experiment and seed size for each species. This was set weighing 10 lots with a known number of seeds (20 to 100) to *E. loxophleba* and *E. astringens* and weighing a batch of 250 seeds for *E. accedens*, Acacia species and *Austrodanthonia*. Once established seed weight for each species and according to the amount reported in Table 1, separated batches for each sub-parcel were defined. The planting was the last week of June 2012 (as shown in the Gantt chart) raking the soil surface with a screwdriver in order to create favourable microsites for germination. The removed soil was placed back in the original place to protect the seeds.

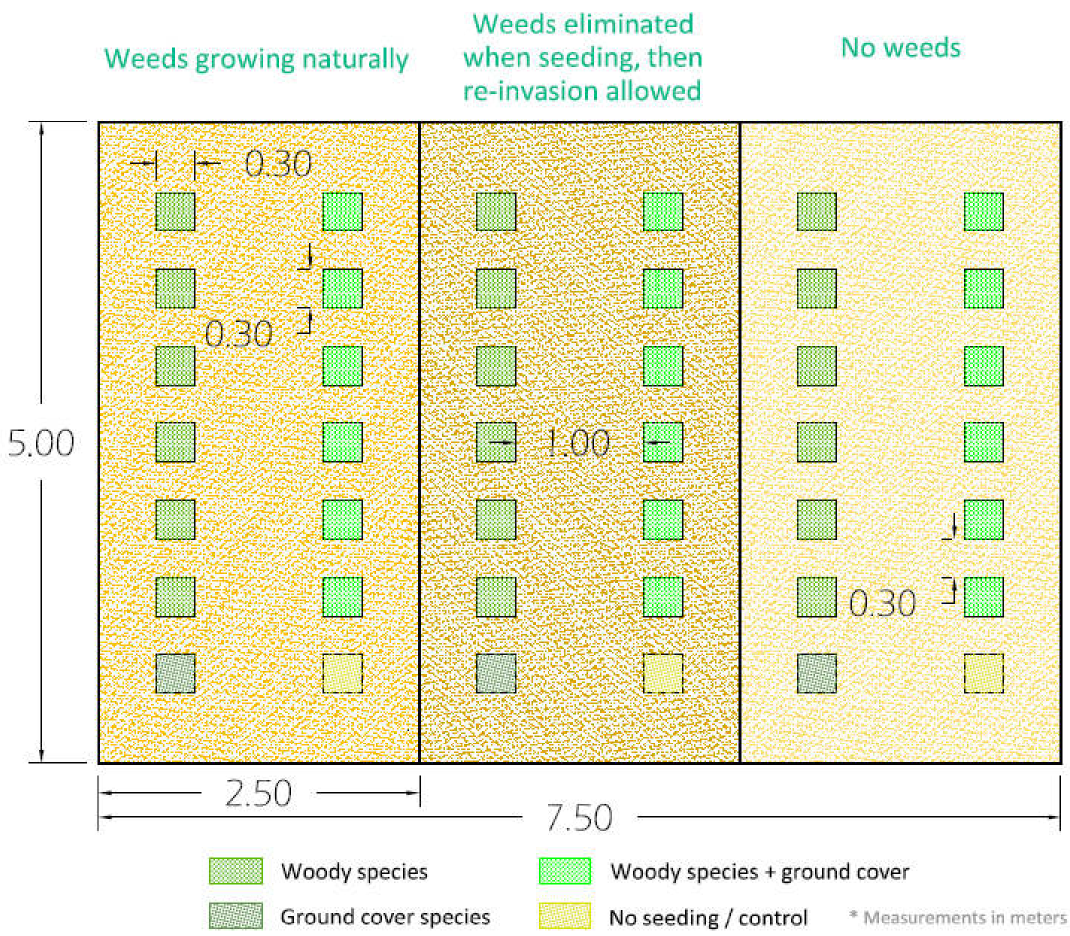


Figure 17. Plot crops organization

Species	Number of seeds in pure plots	Number of seeds in mixed plots
Eucalyptus accedens	500	250
Eucalyptus astringens	289	144
Eucalyptus loxophleba	262	131
Acacia. sessilis	200	100
Acacia pulchella	110	55
Acacia acuminata	54	27
Austrodanthonia caespitosa	200	100

Table 2. Number of seeds per plot

3.4 Field work planning

The next section pretends to realize a chronogram of the different phases and operations in the field.

This chronogram it's presented as a Gantt chart, an essential tool managing projects. The diagram shows the different tasks carried out in time and shows the various dependencies between them.

This tool is intended to track the project in time. This methodology is considered as acceptable since it is easier to understand visually, being adequate to the scope of the project in question, since this is a project with not excessive execution time, period totalling 50 weeks, approximately one year and 2.5 months.

3.4.1 Field work activities

The Gantt chart contains the different variables were recorded in each sub-parcel along the 50 weeks remained experiment.

Monitoring the woody species of the study

- Previous works: think the reason for the experiment, the choice of species, planning and design of the plots and its distribution in the land, preparation of materials and equipment organization in the field.
- Plantation: planting seeds according to the subplot composition.
- First count of emergent plants: in each plot the emerging seeds were counted.
- First record count of survivors: counting of the emerged seedlings surviving. Data were entered in a sheet table in-situ to be transcribed later in *Excel*.
- Second record count of survivors: counting of the emerged seedlings surviving.
- Third record count of survivors: counting of the emerged seedlings surviving.
- Measurement of foliage characteristics. Height and diameter: measured the height of each seedling and two diameters of all parcels.
- Harvest: crop of the survivors plants and introduced in a paper bag to be dried in the oven at the university.
- Biomass measurement of survivors: once the samples were collected and dried in the oven, it came weighing after and create a new table for plant biomass.

Monitoring the native grass

- Late emergence. First count: count of the emerging seeds.
- Late emergence. Second count: count of surviving seedlings.
- Late emergence. Third count: count of surviving seedlings.
- Late emergence. Fourth count: count of surviving seedlings.
- Measurement of the height average: measured the height of each seedling for all plots. The values were listed in the table with the values of width and height of woody species.
- Harvest: the survivor seedlings were cropped and introduced to the paper bags to be dried in the oven at the university.
- Biomass measurement of survivors: once the samples were collected and dried in the oven, it came weighing after and create a new table for plant biomass.

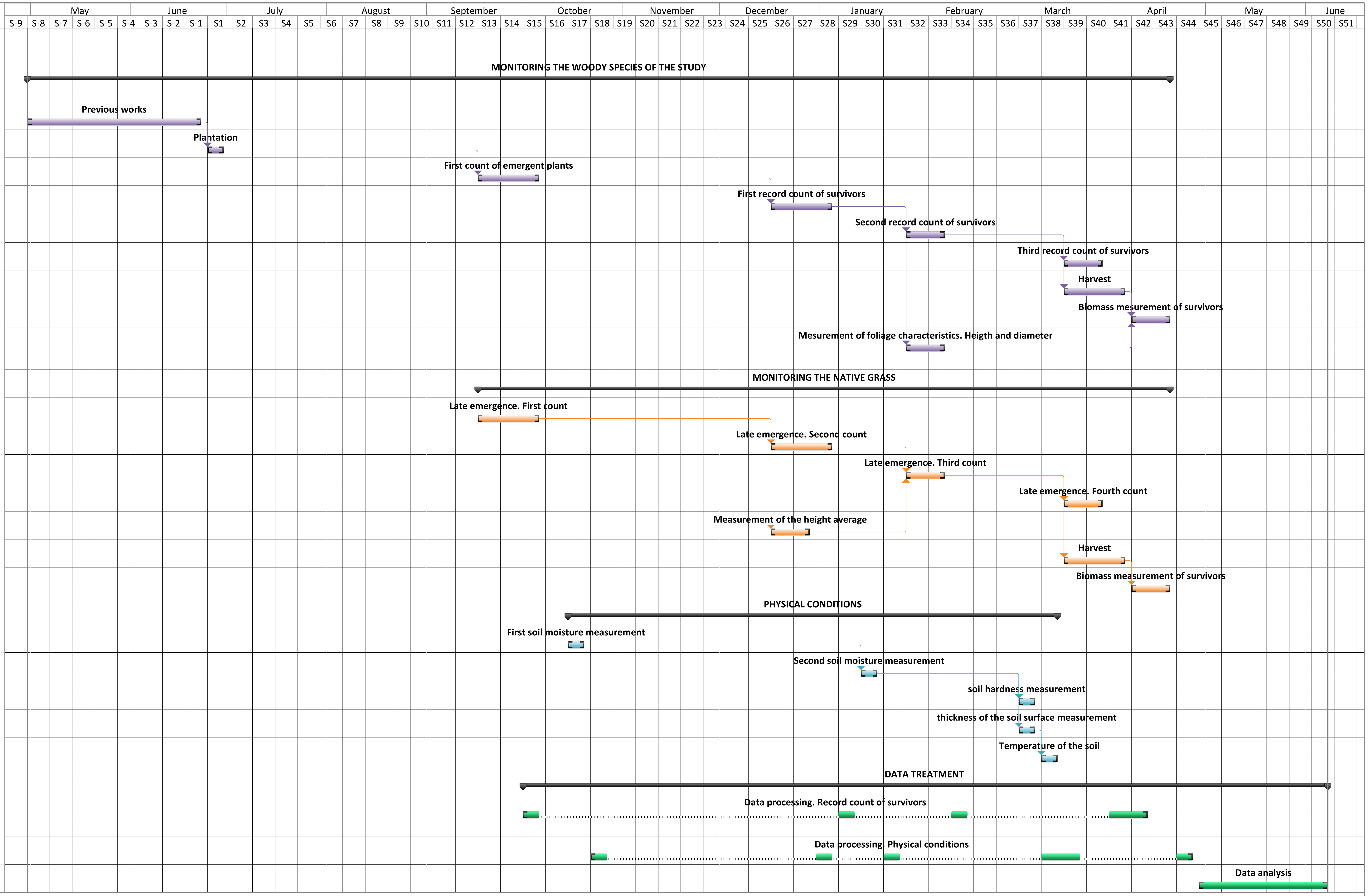
Physical conditions

- First soil moisture measurement: using a penetrometer the soil moisture was measured in each plot. The data collected was entered in a table and took the average per row and treatment.
- Second soil moisture measurement: using a penetrometer the soil moisture was measured in each plot. The data collected was entered in a table and took the average per row and treatment.
- Soil hardness measurement: through a Time domain reflectometry, the soil hardness was measured in two different points in each plot.
- Thickness of the soil surface measurement: the thickness of the sandy soil surface was measured with a metal ruler.
- Temperature of the soil: temperature was measured in two different points in each plot.

Data treatment

- Data processing. Record count of survivors: introduction of the collected data to an *Excel* sheet.
- Data processing. Physical conditions: introduction of the collected data to an *Excel* sheet.
- Data analysis: processing and analysis of the data collected during the stay at Ridgefield.

Id	Task name	Duration	Start
1	*FIELD WORK PLANNING*		
2	**MONITORING THE WOODY SPECIES OF THE STUDY**	**51 sem.**	**lun 30/04/12**
3	Previous works	8 sem.	lun 30/04/12
4	Plantation	1 sem	lun 25/06/12
5	First count of emergent plants	3 sem.	lun 17/09/12
6	First record count of survivors	3 sem.	lun 17/12/12
7	Second record count of survivors	2 sem.	lun 28/01/13
8	Third record count of survivors	2 sem.	lun 18/03/13
9	Harvest	3 sem.	lun 18/03/13
10	Biomass mesurement of survivors	2 sem.	lun 08/04/13
11	Mesurement of foliage characteristics. Heigth and diameter	2 sem.	lun 28/01/13
12	**MONITORING THE NATIVE GRASS**	**31 sem.**	**lun 17/09/12**
13	Late emergence. First count	3 sem.	lun 17/09/12
14	Late emergence. Second count	3 sem.	lun 17/12/12
15	Late emergence. Third count	2 sem.	lun 28/01/13
16	Late emergence. Fourth count	2 sem.	lun 18/03/13
17	Measurement of the height average	2 sem.	lun 17/12/12
18	Harvest	3 sem.	lun 18/03/13
19	Biomass measurement of survivors	2 sem.	lun 08/04/13
20	**PHYSICAL CONDITIONS**	**22 sem.**	**lun 15/10/12**
21	First soil moisture measurement	1 sem	lun 15/10/12
22	Second soil moisture measurement	1 sem	lun 14/01/13
23	soil hardness measurement	1 sem	lun 04/03/13
24	thickness of the soil surface measurement	1 sem	lun 04/03/13
25	Temperature of the soil	1 sem	lun 11/03/13
26	**DATA TREATMENT**	**36 sem.**	**lun 01/10/12**
27	Data processing. Record count of survivors	5 sem.	lun 01/10/12
28	Data processing. Physical conditions	6 sem.	lun 22/10/12
29	Data analysis	6 sem.	lun 29/04/13



Proyecto: GANT PAULA	Resumen	Tarea manual	Sólo duración	Informe de resumen manual

3.5 Working tools and methods

3.5.1 Tools

Soil thermometer

A soil thermometer is a thermometer specifically designed to measure soil temperature. Gardeners find these tools useful for planning plantings and they are also used by climate scientists, farmers, and soil scientists. Soil temperature can provide a great deal of useful information. Soil thermometers include a long probe that allows people to reach deep into the soil. Some must be pulled out for reading, using a traditional mercury bulb thermometer design. Others have a display on the top of the thermometer that may be digital or analogue, allowing people to quickly read the soil temperature. Rank: temperature between -10 to 50° C. Measures: Ø 50 mm x 400 mm

Figure 18. Soil thermometer

Soil moisture with a Time domain reflectometry (TDR)

TMR is an indirect measure of soil water content based on the travel time of a high frequency electromagnetic pulse through the soil; this travel time is used to calculate the permittivity (dielectric constant) of the material. The TDR probes are inserted directly into the soil for in situ measurement at the desired soil depth. The measurement takes only seconds, and the instrument can be attached to a data logger for ongoing measurements. The volumetric water content in the soil was recorded with a portable hidrosensor probe 12cm (HydroSense II, Campbell Scientific ®)

Figure 19. Portable hidrosensor

Drying oven

Oven for drying plants biomass, among others, with four compartments for handling variety of heights for the location of the trays. It handles temperatures in a range of 80ºC.

Analytical balance

The analytical balance is an instrument used in the laboratory, which measures the mass. Its most important feature is that they have very little margin for error, making them ideal for use in highly accurate measurements. The analytical balances usually are digital, and some can display information in different systems of units. The balance that it's been used in the laboratory work, displays the mass of a substance in grams, with an uncertainty of 0.00001g (0.01 mg).

Figure 20. Analytical balance

Metallic ruler

The thickness of the surface layer of sandy soil was determinate with a metal ruler 0.5 mm resolution (celco ®).

Penetrometer

Hardness was established with pocket soil penetrometer (H4200, Humboldt ®). It's a laboratory instrument used to determine the compressive stress in the field. For which traces a circle with its centre on the ground, then the penetrometer vertically placed directly against the floor and perform shooting around the circle and the centre. Penetrometer recorded values are evaluated using a table provided by the manufacturer, the average value of the penetrometer readings can be traced to the failure envelope.

Figure 21. Penetrometer

Magnetic Stirrer Hot Plate

It combines the features of both Hot Plates and Magnetic Stirrers. Heating and stirring operate together but are independently controlled. Electronic speed control from approximately 150 to 1.500 RPM. Hot Plate features: provides a reliable source of controlled heat for the laboratory. The heating element is recessed and bonded into the underside of the aluminium alloy plate for total thermal efficiency. A ceramic board provides insulation and baffle plates ensure that the housing remains cool even after prolonged operation with temperatures up to 400°C. The large, 200mm x 180mm, uncoated top plate has a flat machined surface. The simmerstat provides continuous adjustment of plate temperature from warm to approximately 400°C, but does not hold the temperature to a specific set temperature. A simmerstat control is better suited to boiling water than a thermostat control.

Seed germination of Acacia is performed by a stimulus through scarification with hot water (just below boiling point) for about 1 min 45 seconds.

Figure 22. Magnetic Stirrer hot plate

Secateurs

Type of scissors for use on plants. They are strong enough to prune hard branches of trees and shrubs, sometimes up to two centimetres thick. They are used in gardening, arboriculture, farming, flower arranging, and nature conservation, where fine-scale habitat management is required.

Sampling cardboard bags

Made with brown or white kraft paper with square background and different sizes depends on the sampling.

Figure 23. Secateurs and cardboard bags

3.5.2 Data analysis and statistical methods

This section aims to establish procedures for the processing and analysis of data and the justification of the form of how it's been working.

Nomenclature

The different project scenarios will be referenced by the following convention alphanumeric:

- The first two letters (NW, WA or WE) refer to treatment (No Weed, Weed After or Weed)
- The third letter refers to the type of crop (P or M) Pure or Mixed, respectively.
- The fourth position corresponds to a number from 1 to 7, according to the following relationship:
    1. *Acacia acuminata*
    2. *Acacia pulchella*
    3. *Acacia sessilis*
    4. *Eucalyptus accendens*
    5. *Eucalyptus astringens*
    6. *Eucalyptus loxophleba*
    7. *Austrodanthonia caespitosa*
- After the underscore (_) contains a number value of 1 to 4, corresponding to the count made for the scenario. In the case where that number is displayed together with the letter P, it will refer that this count is for *Austrodanthonia caespitosa* native grass.

As an example, NWM5_3 would refer to the scenario No Weed Mixed for *Eucalyptus astringens*, third count. WAP1_2 would refer to Weed After Pure for *Acacia acuminata*, second count. WAM6_1P would reference Weed After Mixed for the native grass, *Austrodanthonia caespitosa,* living with *Eucalyptus loxophleba*, first count.

Field data

Given the data collected in the field, it has ten independent samples for each stage of the project and for each count carried out, having a total of four counts over time.

Each count, involve the number of plants have been recorded in each plot existing at the moment of the count in question, having made measurements of biomass,

soil moisture measurements and size characteristics of the plant species in each plot.

The entire field data collected is attached in the *Appendix section*.

Exploring the data

Firstly, a study of the effects of establishing appropriate indicators to synthesize field data obtained will be done. This study will be conducted by the analytical results (normality tests) and graphical results (Q-Q graphs, graphs of frequency). It's been used the *IBM SPSS Statistics 21* program for managing and analysing data, as well as for the extraction of different charts and graphs of results.

The first aspect of vital importance to keep in mind to make statistical inference lies in the sample size. For each stage of the project will have 10 samples, which the pattern of distribution it's not known. It is vital, therefore make a test for normality in all samples of each stage of project in effects to make a decision on the best possible indicators of central tendency and dispersion for data synthesize.

Given the small number of samples, will be used the test of Shapiro-Wilk normality (GEORGE A. CANOVOS, 1988; SHAPIRO-WILK, 1965). With this test is performed a hypothesis testing where the null hypothesis is H_o: samples come from a normally distributed population. The significance level used is the usual 5%. If the p-value obtained in this test is less than the significance level set, the null hypothesis will be rejected, concluding that the samples did not follow a normal distribution.

The distribution pattern of each population is crucial to be able to make a decision about the goodness of statistical estimators used, as a function of the estimator used, the reliability of the results can vary greatly if it's not done an exhaustive study on estimators of central tendency diversion (data synthesizing estimators).

Selection of statistical estimators

Once explored the data, a decision could be objective about the normality or not of the distribution pattern of populations. There are two clearly different scenarios: one where the normality assumption is valid and another where this assumption is not valid.

If the normality assumption is not valid, it won't be convenient to use the classic statistical data, such as are the mean sample and standard deviation sample, since these estimates are strongly influenced by outliers and lose validity as the data come from populations that have asymmetric distributions and outliers.

If the normality assumption is sufficiently valid, meaning that the significance of the Shapiro-Wilk normality test is greater than 5%, could be used, without loss of validity, the median (50th percentile) and, consequently, the interquartile deviation (semidiference between the first and third quartile). Proceeding in this way with the median and interquartile deviation estimators could be better to capture the behaviour pattern of population distribution in the case of non-normality, thus providing better results than using the classical estimators.

If the distribution pattern of the samples follows a normal, the mean and the median tend to coincide and therefore the difference between standard deviation and interquartile deviation will be shorter. To accelerate the data processing and being equally valid procedure, will be used the median and the interquartile deviation also for cases where the normality assumption does not rise being rejected.

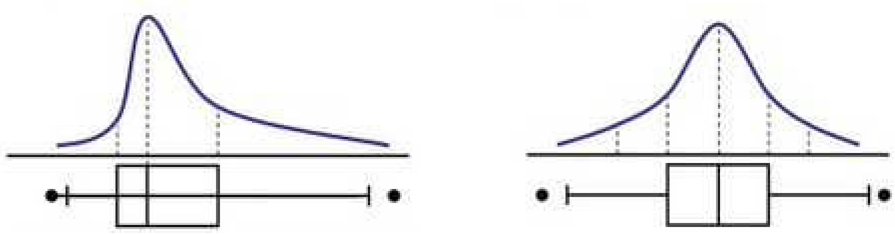


Figure 24. No normal distribution vs. normal distribution

In a box-plot diagram, the ends of the box represent precisely the interquartile range (twice the interquartile deviation). As will be seen in the analysis of normality developed in the next *CHAPTER 4*, the box-plots of different project scenarios tend to resemble more represented in the left side of Figure 24 than in a normal distribution box-plot. This demonstrates another approach of the not representative of the mean estimator and standard deviation estimator in a not normal distribution as it will result in this circumstance.

In conclusion, synthesizing estimators used in this project are the MEAN and interquartile standard deviation, using such indicators as less "rigid" front Outliers, reduces the bias of the two estimators covered, representing a more correct reality of the observations.

Data processing. Tendency analysis

Using data synthesizing estimators for each stage of the project, the mean and interquartile standard deviation as mentioned in the previous section and as will justify later, it's proceed to make a summary of the data available.

It has four counts over time for each stage of the project, using the mean to synthesizing the counts in each scenario. Will be generated a vector of four components where its components are the mean for each scenario count of the project.

Analysing the slope of these vector graphs for each species could be seen the seedling evolution ratio based on the different treatments and the coexistence with native grass.

Usually the used regression models in order to synthesize the pattern of trends in evolution of species, but also the best indicator used to analyse the growth trend is the first derivative, or slope, of the emergence function (vector graphs before mentioned) that could show how many seedlings died over the time. Undoubtedly, the derivative provides information of the velocity of growth/decline of populations over time.

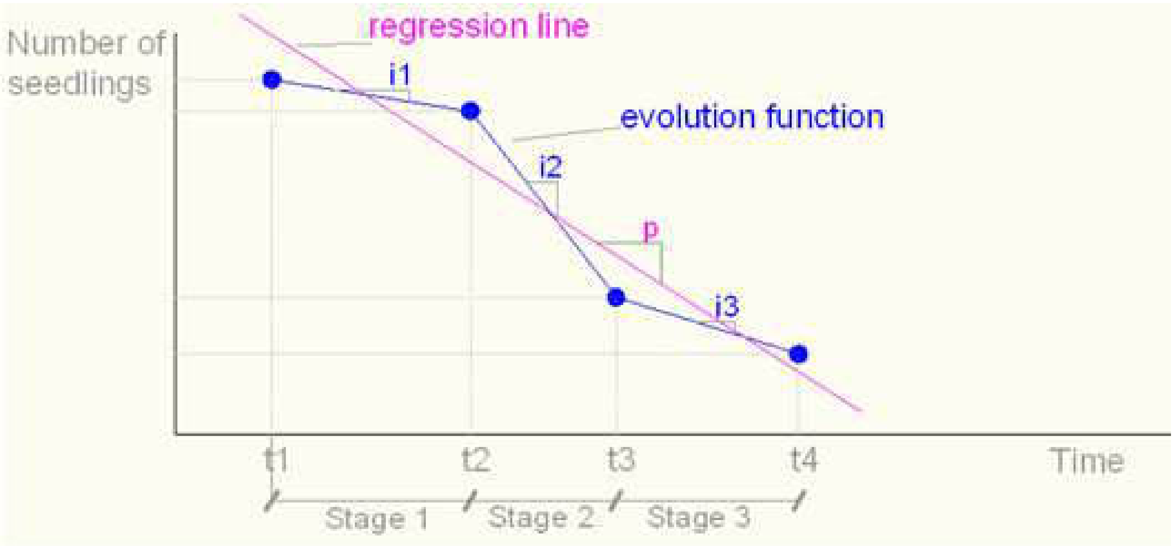
The number of counts is small, only four. This does not allow an accurate statistical inference using the regression analysis; it's too rugged and rude and some information could be lost.

For this reason, the author of the project proposes to use an analysis method related with the first derivative of the emergence function, process that allows contemplate different growth/decline trends over the time (as an example, the effects caused because of the season).

This growth/decline trend of the evolution function would represent the mortality along the time of the seedlings (according to the data collected and results of this project). Because of that, it's defined the Perish rate as the velocity of mortality of the seedlings along a specific period of time, being the absolute value of the formal definition of the first derivative's emergence function.

This methodology pretends to analyse growth/decline trends instead of using the classical regression models, which do not have enough valid in that case.

However, will be used a linear regression to study the seed size related with the perish rate. In the Figure 25 shows the different trends along time between the regression line model and the experimental evolution function. The average of the perish rate in each stage will be close to the linear regression line. Because of that, one could calculate the average of the perish rate as the linear regression line. This value it's used in this project to relate the seed size with the perish rate, where perish rate is the growth/decline trend of the evolution function, in contrast of the general meaning that define growth rate as the temporal evolution of the seedling height or biomass (PETER J. GROSE, 2013; JASON M. STEVENS and JEFFREY S. FEHMI, 2011; et al.).



$$i_j \rightarrow Prerish\ rate\ at\ stage\ j, calculated\ as\ the\ first\ derivative$$

$$of\ the\ evolution\ function\ at\ stage\ j$$

$$p \cong \frac{i_1 \cdot (t_2 - t_1) + i_2 \cdot (t_3 - t_2) + i_3 \cdot (t_3 - t_2)}{t_4 - t_1} \rightarrow Average\ of\ the\ perish\ rate$$

Figure 25. Linear regression model vs. Evolution function

Data post-processing

Analysing the different trends and graphs, survival will be performed in a discussion of the different growth trends for each plant variety depending on the type of treatment used, as in the coexistence between the species in question.

Microsoft Excel software and *IBM SPSS 21* software will be used to perform various histograms relating the different plant varieties with the different treatments applied to each plot. Thus histograms are keys to extract the main conclusions of the project that synthesizes all the information and present a clear, visually conveying the main evidence in the behaviour of seedlings.

Validation procedure

The tool used to establish relationships between the different indicators (indicators of growth rates, survival indicators and soil moisture) is the correlation analysis.

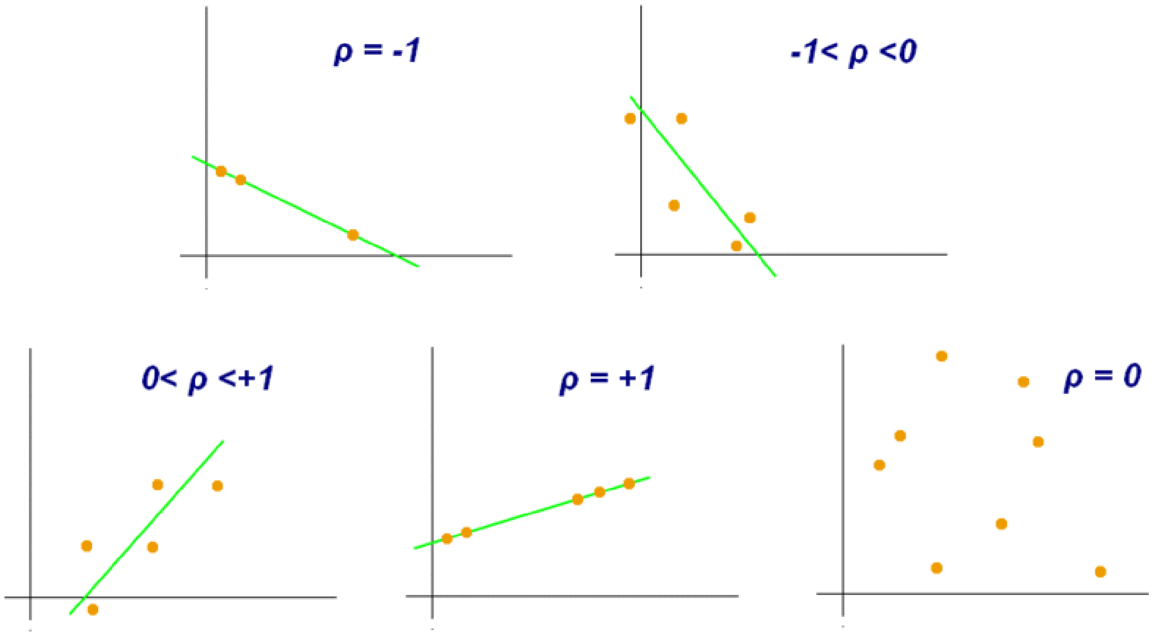


Figure 26. Pearson correlation scenarios

The Pearson correlation, ***ρ***, is a measure of the linear correlation (dependence) between two variables X and Y, giving a value between +1 and −1 inclusive, where 1 is total positive correlation, 0 is no correlation, and −1 is negative correlation. It is widely used in the sciences as a measure of the degree of linear dependence between two variables.

As an example, and as happens in this project, the correlation factor between growth/decline rate and seed size, presents a dispersion graph similar to the second image of the *Figure 26.* Can be seen that the Pearson correlation sign it's the same as the slope of the linear regression of the dispersion graph. This fact indicates an inverse relation between the two variables, is to say; according to this case when the seed size increases, implicate to have a lower growth/decline rate.

This relation became harder as the absolute value of the Pearson coefficient tends to one ($|\boldsymbol{\rho}| \rightarrow 1$).

To give more power to different arrived conclusions, cluster graphs will be added, where using a linear regression model could visually show the type of relationship between indicators compared (the seed size and the growth/decline rate).

CHAPTER 4. RESSULTS AND DISCUSSION

This chapter will present the different results obtained after the processing and analysis of data. It also made a critical assessment of the different results.

4.1 Data exploration

It's proceeded to indicate the results obtained in the normality study conducted at different scenarios of the project for different plant varieties to a particular count, trying thus indicate the growth pattern of each variety. The results shown are relative to a descriptive analysis of the estimators, as well as an analysis of box-plot presented several graphs and frequency distribution histograms and QQ plots. With this study is intended to visually indicate the validity of the normality assumption on the different plant species studied.

It's also performed the test of Shapiro-Wilk normality, indicating in the tables the level of significance for each stage of the project. Thus, through an analytical procedure is to make an objective decision on the validity of the normality assumption, thus taking the appropriate decisions concerning the choice of estimators.

Finally, the different estimators considered in effects to highlight the differences and the error when using classical synthesizing estimators or relating to quartiles will be tabulated.

4.1.1 Analysis of plant varieties

If the seedling count data over time are filtered, depending on the treatment, the type of seedling and the plot type (mixed/pure), it shows that the growth of plant varieties has a large spread between plots for the same case of study. The following part intends to reflect this dispersion by analysing the different growth patterns of each seedling.

1- *Acacia acuminata* in the first count

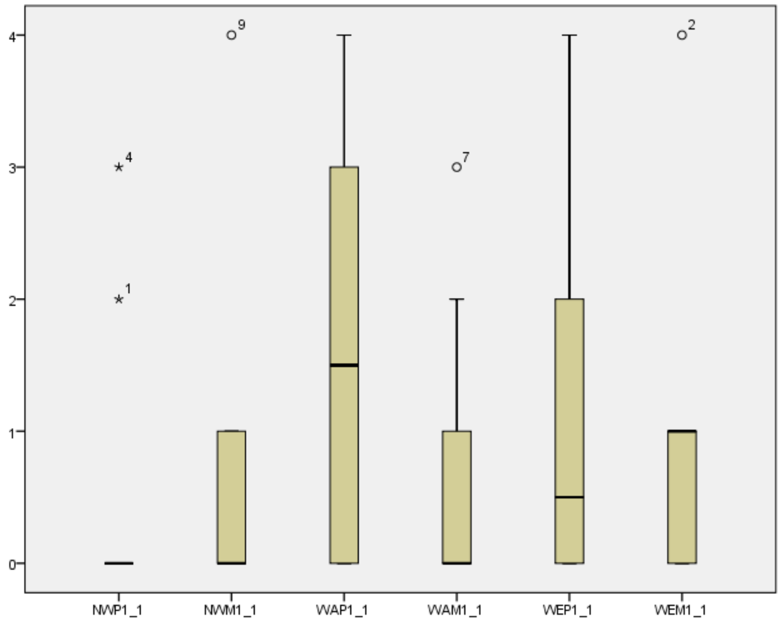
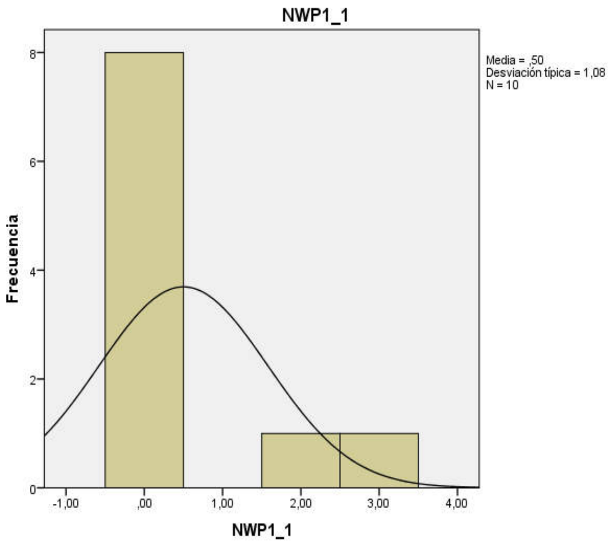
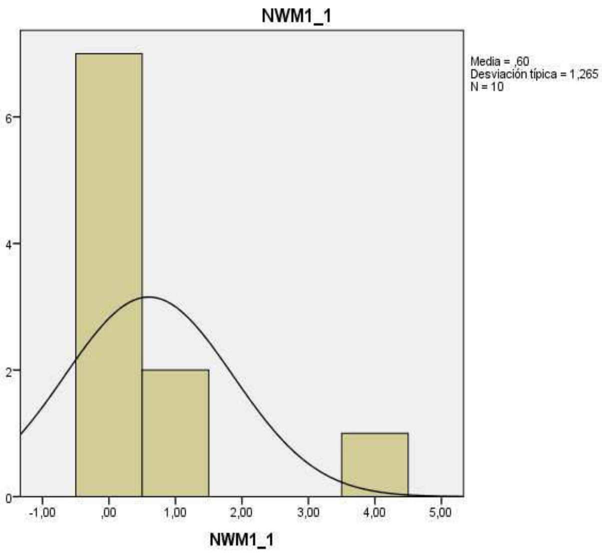


Figure 27. Box plot for *A. acuminata* depending of the treatment. First counting





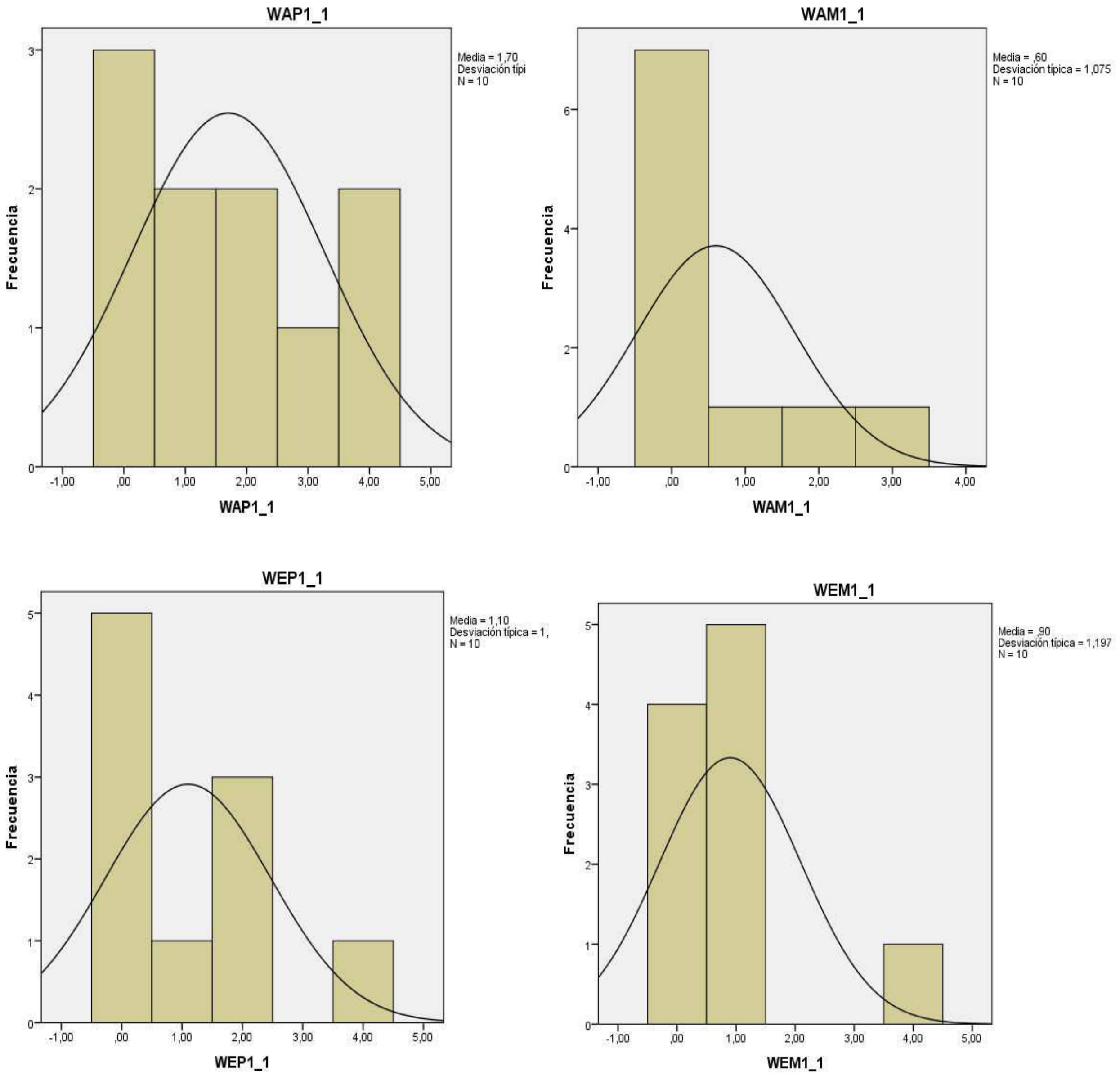
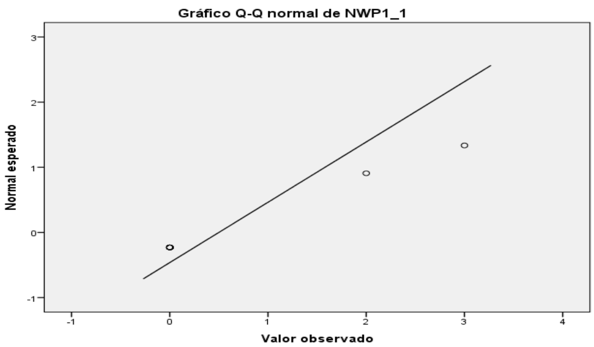
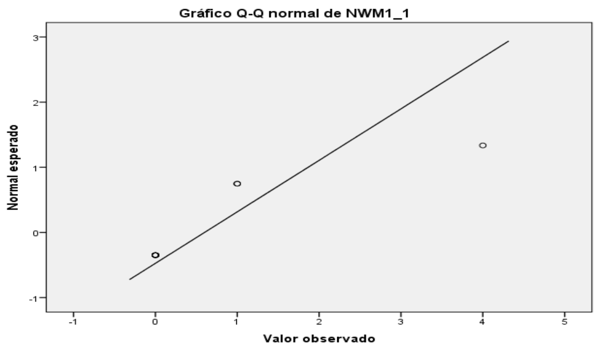


Figure 28. Frequency histogram for *A. acuminata* depending of the treatment. First counting





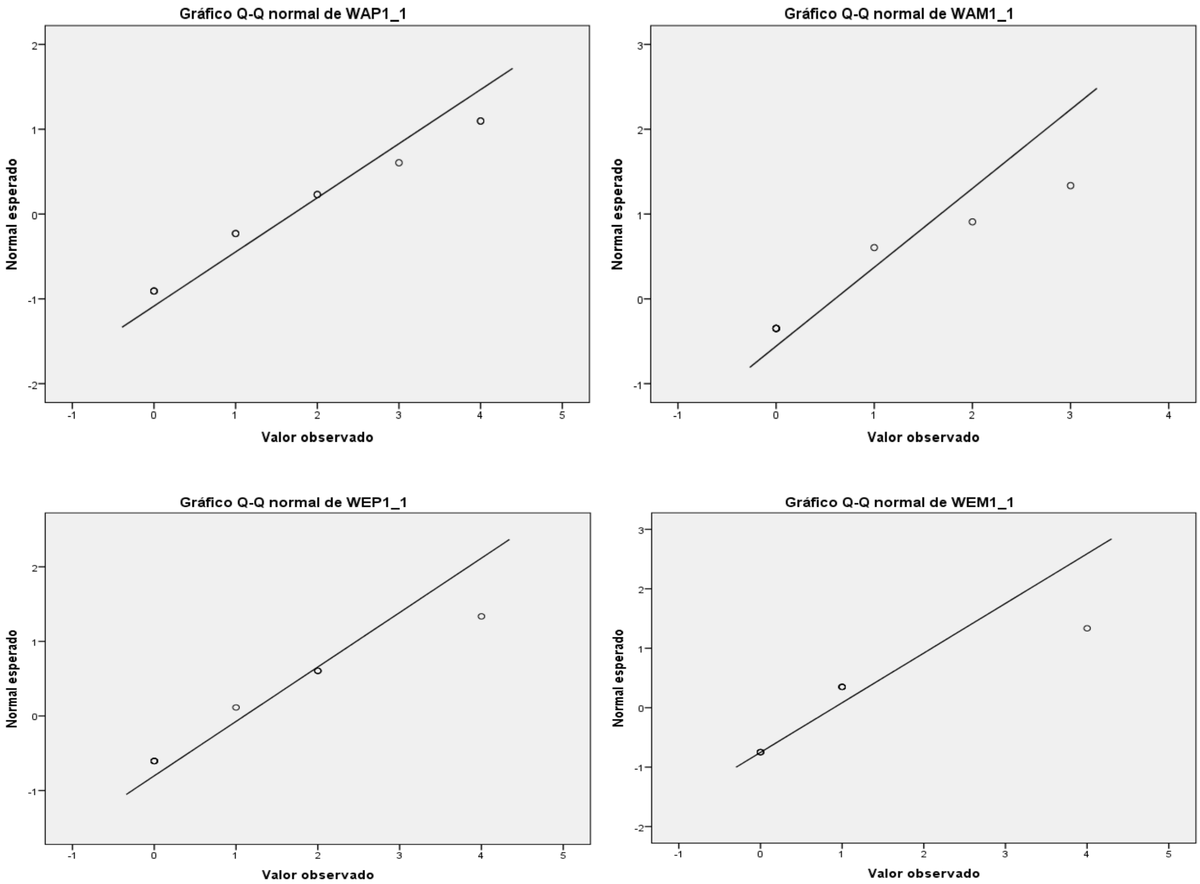


Figure 29. Q-Q Graph for *A. acuminata* depending of the treatment. First counting

2- Acacia pulchella in the second count

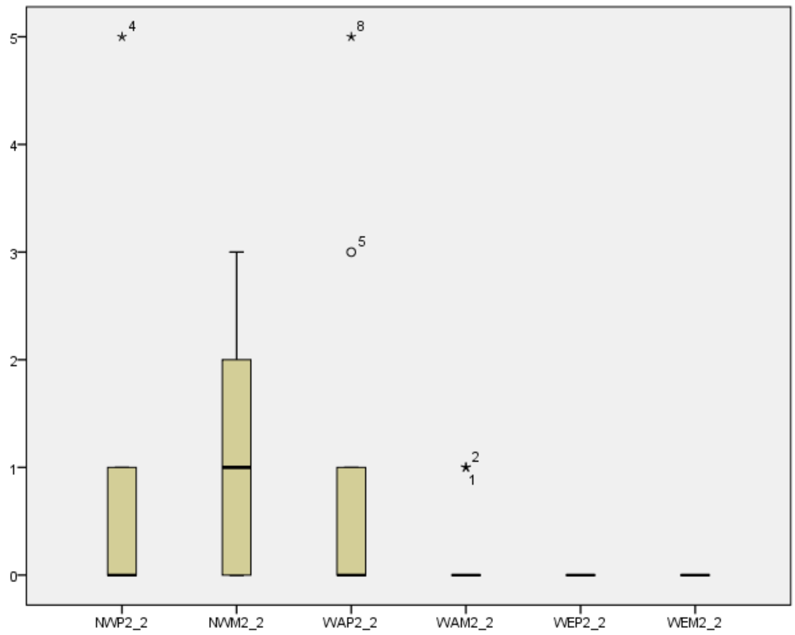


Figure 30. Box plot for *A. pulchella* depending of the treatment. Second counting

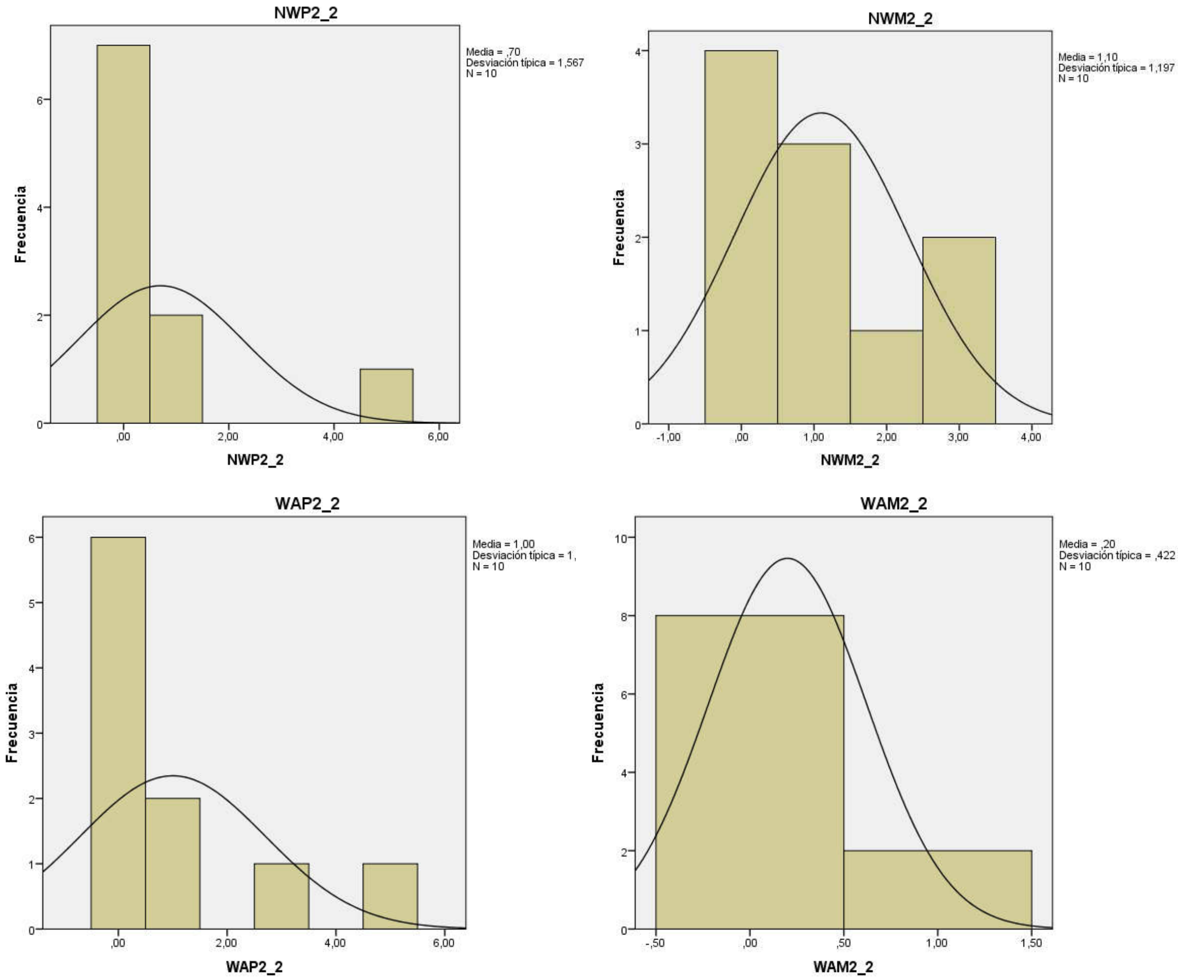
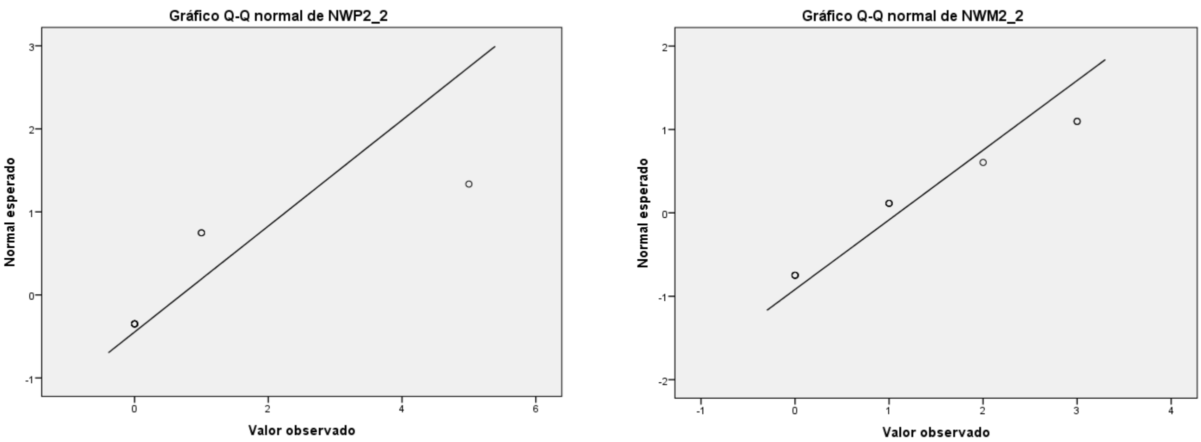


Figure 31. Frequency histogram for *A. pulchella* depending of the treatment. Second counting



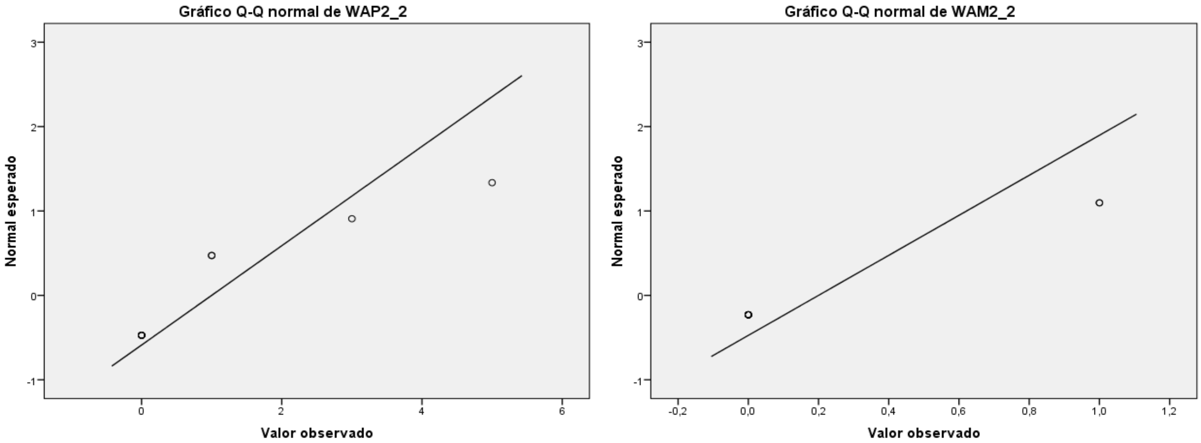


Figure 32. Q-Q Graph for *A. pulchella* depending of the treatment. Second counting

3- *Eucalyptus accedens in the third count*

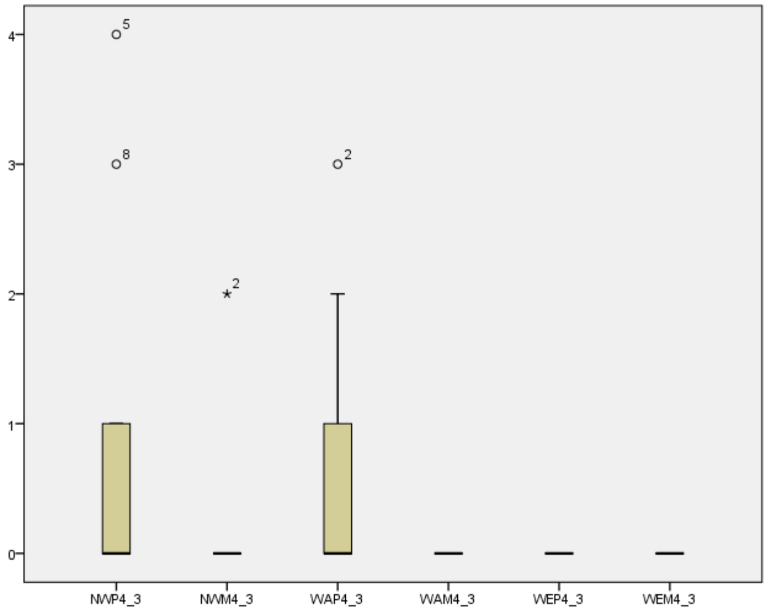
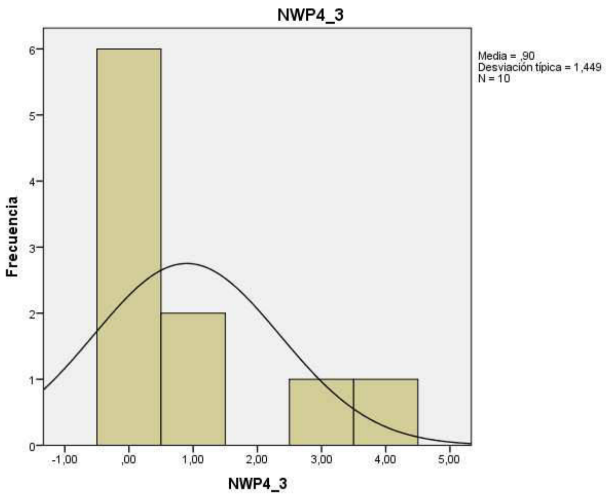
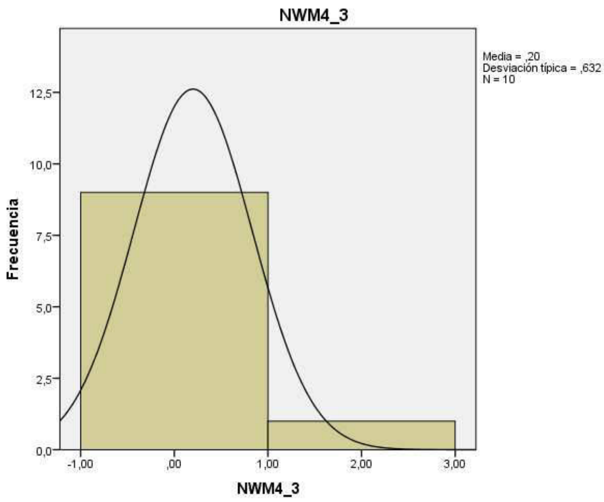


Figure 33. Box plot for *E. accedens* depending of the treatment. Third counting





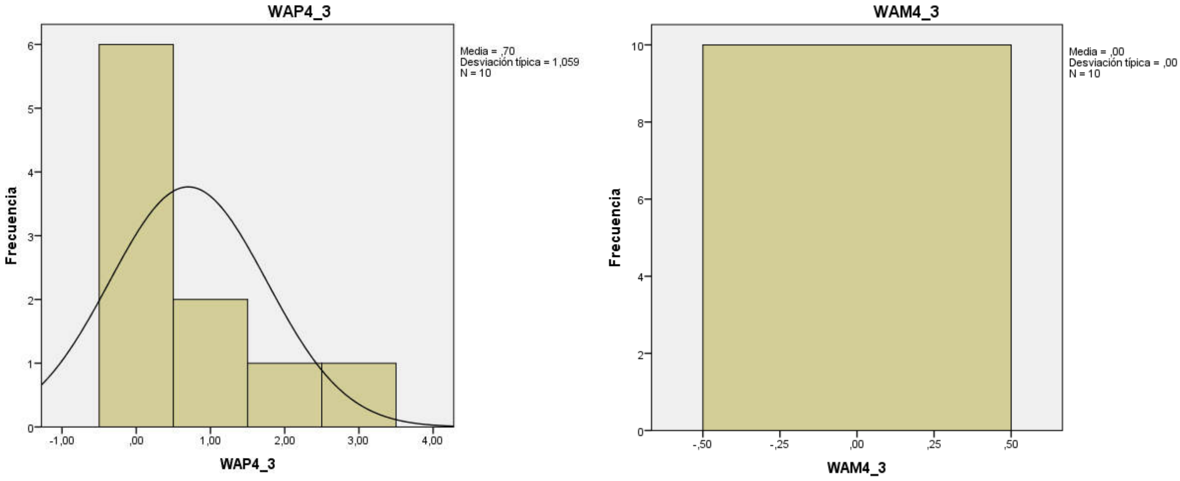


Figure 34. Frequency histogram for *E. accedens* depending of the treatment. Third counting

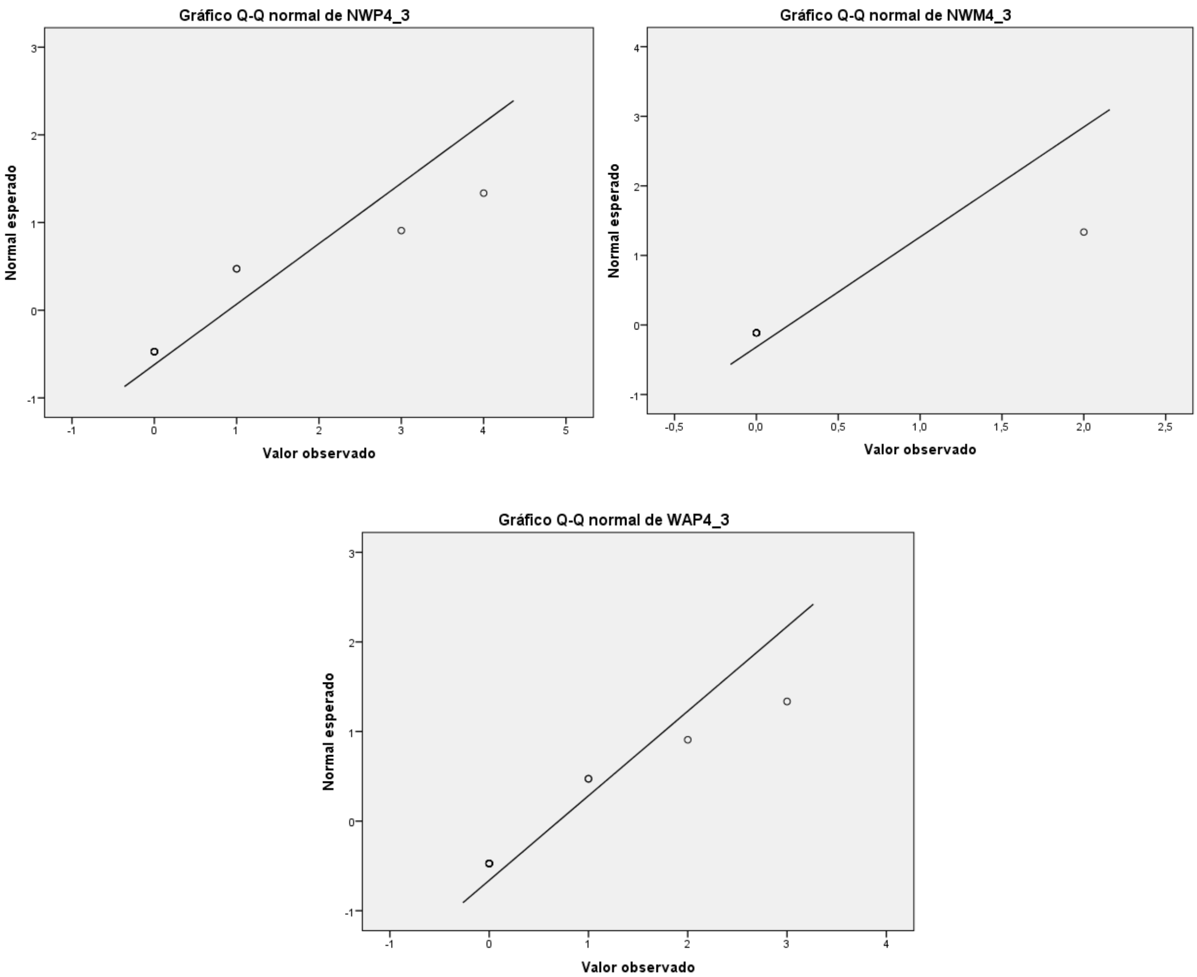


Figure 35. Q-Q Graph for *E. accedens* depending of the treatment. Third counting

4- *Analysis of native grass in coexistence with Eucalyptus astringens, first and second count*

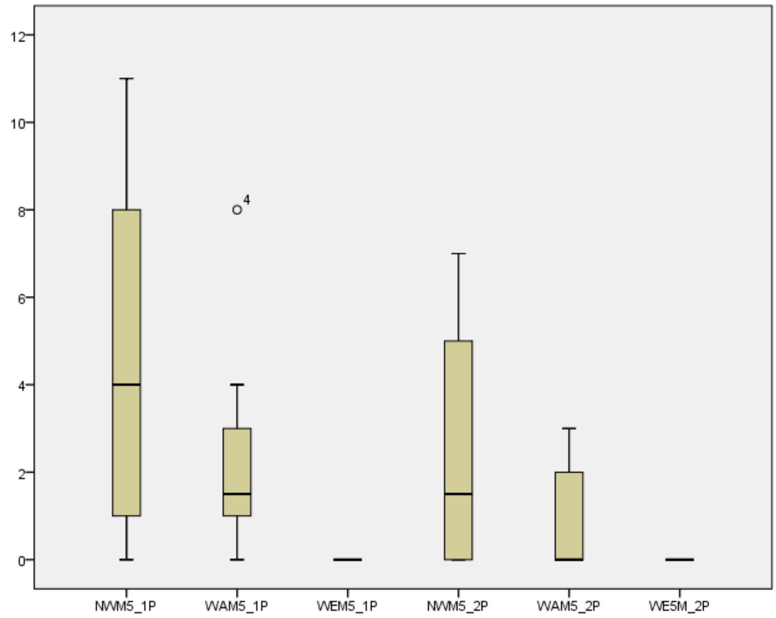


Figure 36. Box plot for native grass coexisting with *E. astringens* depending of the treatment. First and second counting

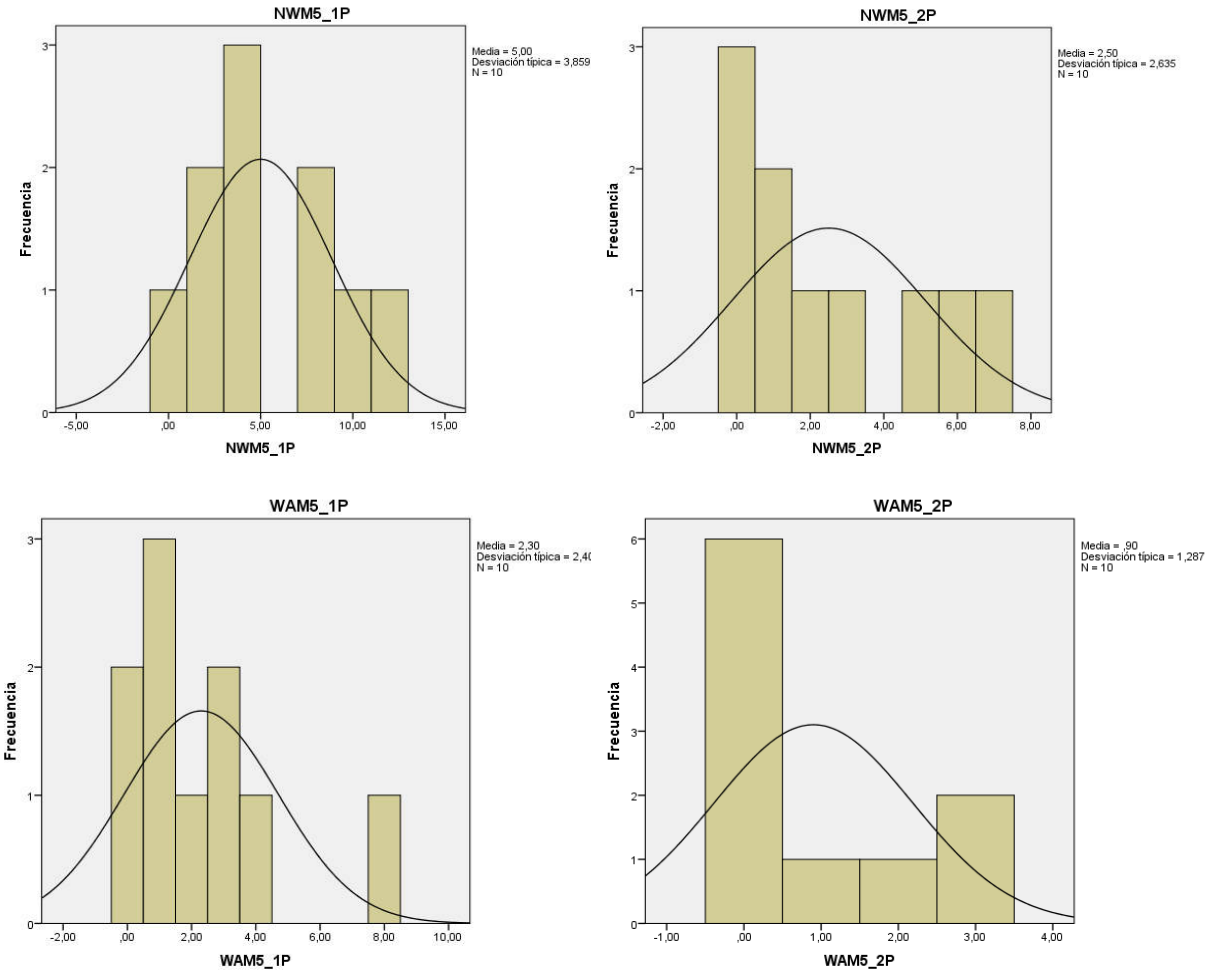


Figure 37. Frequency histogram for native grass coexisting with *E. astringens* depending of the treatment. First and second counting

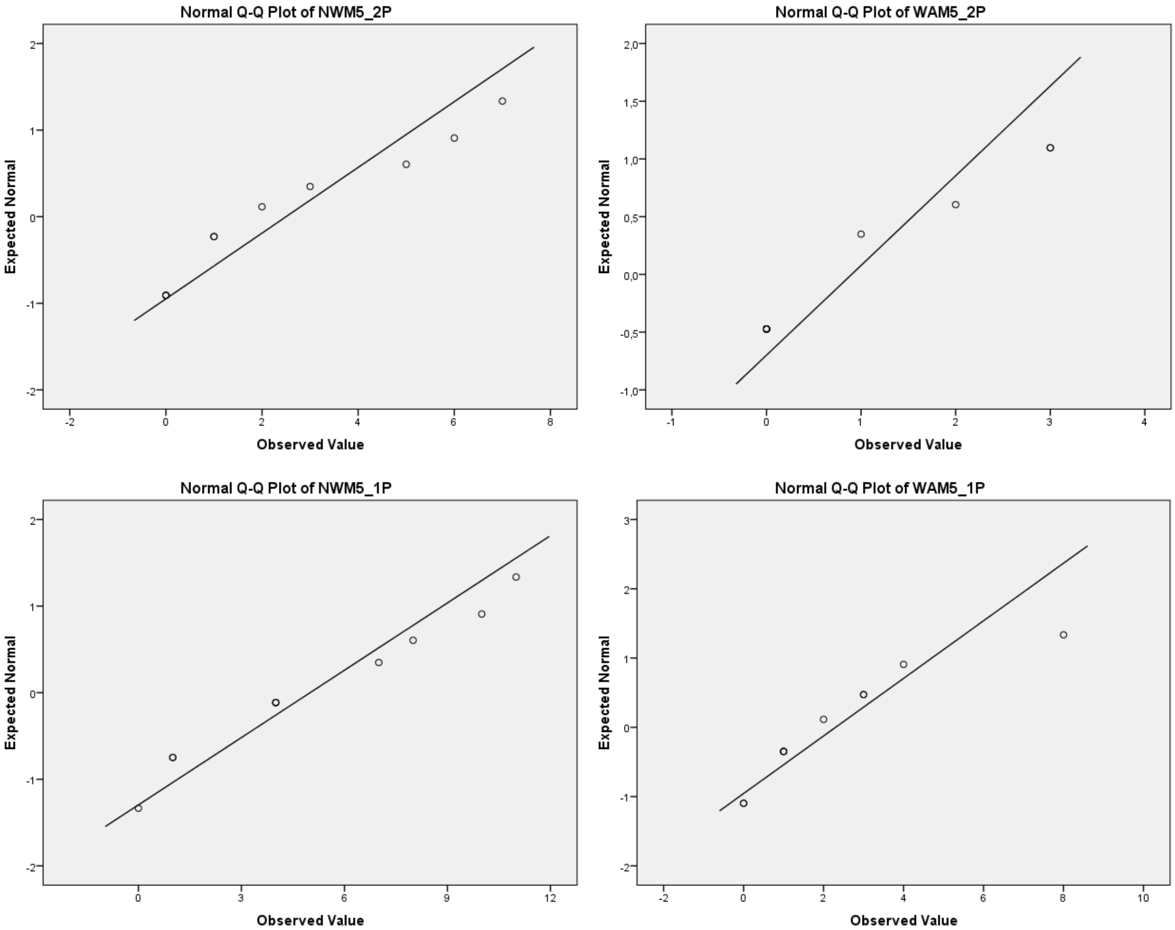


Figure 38. Q-Q Graph for native grass coexisting with *E. astringens* depending of the treatment. First and second counting

5- Analysis of native grass, Austrodanthonia caespitosa, first and second count

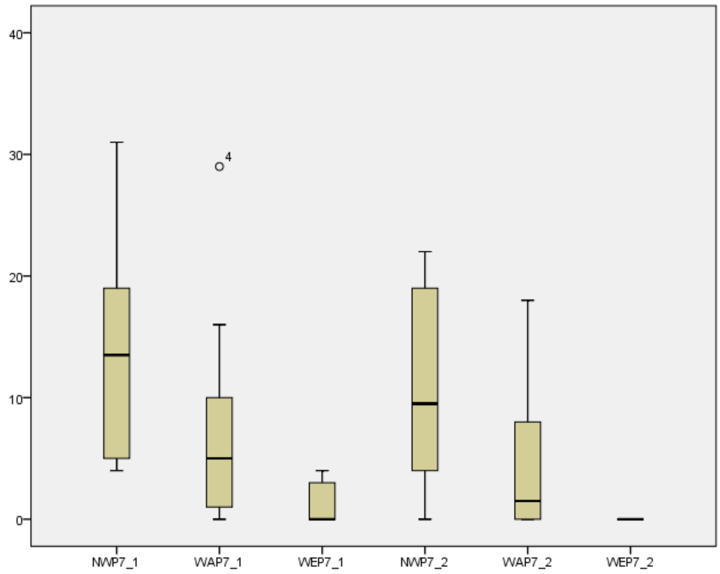
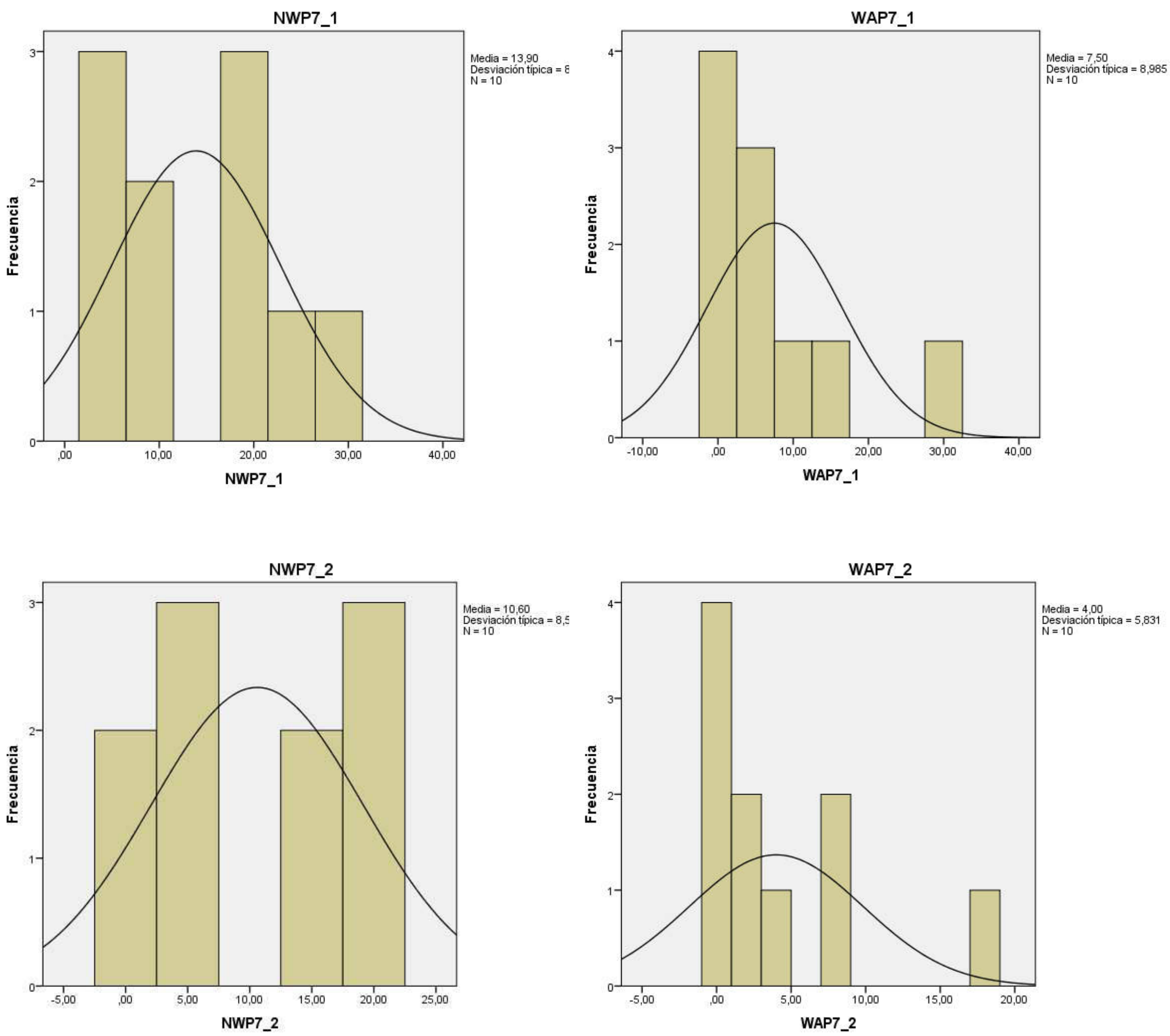


Figure 39. Box plot for native grass *A. caespitosa* depending of the treatment. First and second counting



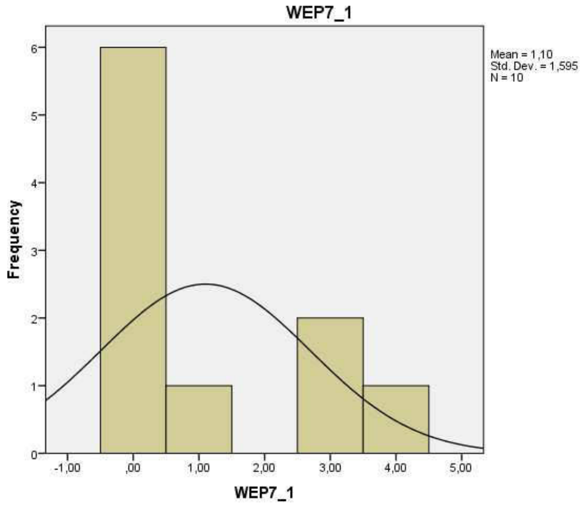
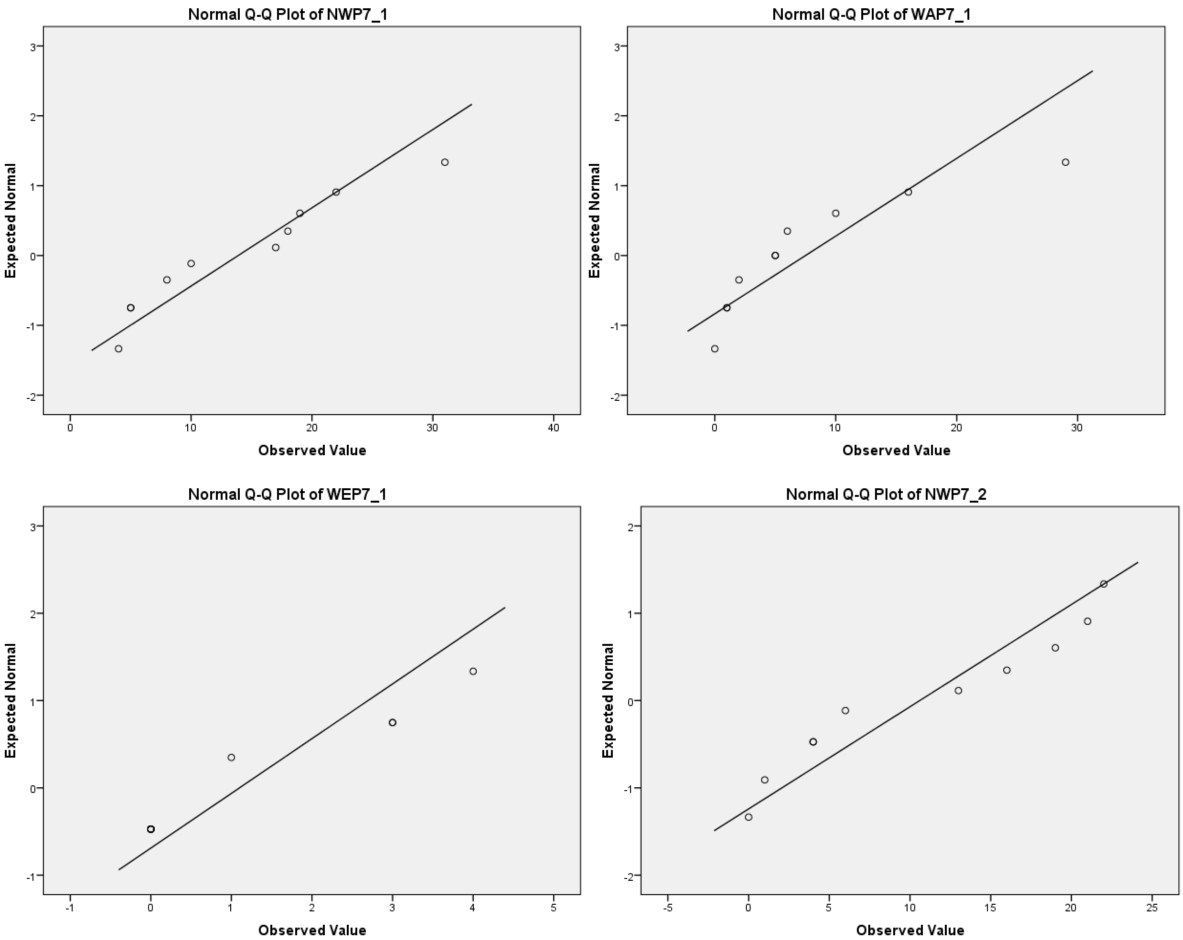


Figure 40. Frequency histogram for native grass *A. caespitosa* depending of the treatment. First and second counting



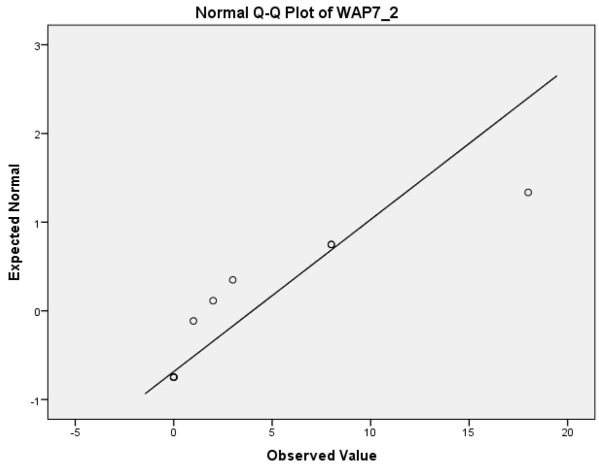


Figure 41. Q-Q Graph for native grass *A. caespitosa* depending of the treatment. First and second counting

Comments concerning the analysis of varieties

Having analysed the three groups of graphic scenes relating to the project: NWP, NWM, WAP, WAM, WEP and WEM for different counts and referred to the different varieties of plants, it can be concluded that the growth pattern of different seedlings in each of the plots do not follow a normal distribution. This evidence is seen observing the following features for each series of graphs attached:

1. In each of the boxplots shows that do not follow normal distributions patent configuration, since the box is not centred or symmetrical.

2. In each frequency histogram shows the non-symmetry of the histogram bars about the vertical central axis of the graph, marking clearly asymmetric distribution with a tail in its extreme right.

3. Analysing the different graphics QQ normal, could be observed that the points do not fall on the line, thus indicating that the distribution is not normal.

4.1.2 Normality tests

It's been performed a normal test on each of the different counts of each stage of the project. Under this test, it's pretended to analyse analytically the validity of the normality assumption on the distribution pattern of seedling growth in different plots. In the Appendix, are attached all the tables for the Shapiro-Wilk test performed on all samples.

These tables reflect the significance value for each project scenario and for each count, marked in red scenarios which reject the null hypothesis of the test (the samples come from normally distributed populations). Green colour indicates the stage where the significance results obtained in the test exceed the pre assigned level of 5%, thus having no reason to reject the null hypothesis.

4.1.3 Differences between estimators. Median vs. Mean

The following part proceeds to make a comparison between the estimators of central tendency candidates to synthesize data from the study populations. In the Appendix, there is a table based on central tendency estimators, which lists the following statistics:

- Median (Second Quartile)
- Mean
- Standard Deviation
- First Quartile
- Third Quartile

Using these tables is intended to denote the difference between employment of median estimator and mean estimator, difference caused by the invalidity of the acceptance of the hypothesis of normality in the distribution pattern of population growth.

After analysis of these tables can be seen the error in the estimate instead of using the mean, and that in this way the data are overestimated, leading to survival that may not be representative considering the great influence of extreme values in the estimator mean. The error is significant, being more prudent use of the median as a parameter estimator synthesizing data, thereby providing more conservative results concerning the survival of various species of plants depending on the applied treatments.

4.1.4 Conclusion on data exploration

After analysing the results of the normality tests for different plant varieties and individual analyses performed, where it has been shown by analytical and graphical the invalidity of the hypothesis that the variables are normally distributed are made the following thoughts:

- Based on the results of the normality test, related to Shapiro-Wilk analysis, which is of interest in this case because of the small number of the sample, it is concluded that the crops do not follow a normal distribution, not being correct use of the average statistical power when working with the different variables. The p-value obtained in the Shapiro-Wilk analysis result below the predetermined significance of 5% in most cases, marking graphically the no normality analysing the box plot and the frequency histograms attached.

- Behaviour variables it's repeated for other plant varieties tested, as well as for different counts done in time.

- It therefore decides not to use the statistical average as a proxy measure of central tendency to summarize the characteristics of each stage of the project, being more convenient to use the median to be an estimator less sensitive and more reliable if the distribution is not symmetric, since it's not distorted by outliers.

- In order to consider the variability of the measures of central tendency, will be used to interquartile deviation instead of the standard deviation, thus being consistent with the previous point. Indeed, the use of average and standard deviation as parameters to synthesize the distribution of samples is adequate if the distribution tends to be normal, which does not occur in the case in question. It's therefore necessary to employ statistical estimators less sensitive to extreme distributions submit and are not symmetrical, such as may be the median and interquartile deviation.

In conclusion, paragraphs and sticking to the above discussion, from this point will be used as a measure the MEDIAN indicator of central tendency, using the INTERQUARTILE DEVIATION (semi difference between the first and third quartile) as a measure of dispersion of data regarding the median, which process is more appropriate for the case in question in terms of reliability of the results of employing the classical estimators (mean and standard deviation).

4.1.5 Causes of non-normal distribution patterns

The small sample size force to proceed with a method that does not imply that the distribution is normal because there is no clear evidence of this fact with the so small sample, thus forcing to proceed with a methodology that fits distributions asymmetric and non-normal, as is working with quartiles as data synthetise estimators. If the sample size increase, it could be that the normality assumption was valid, but lack of data, will be considered at this level that the distribution of seedling growth in different plots do not follow a normal pattern.

4.2 Temporal evolution of seedlings

To analyse the evolution of seedling growth over time will be done an analysis of the growth/decline rate, and analyse the evolution of the number of seedlings recorded in time depending on the treatment provided to each plot.

It's argued the goodness of regression models compared to a trend analysis using the growth/decline rate of seedlings. Later, the graphs attached relating to the analysis of the evolution of seedlings.

From this point, and in this project, to the following ones, the growth/decline rate will be mentioned as perish rate, understanding perish rate as indicated in the *3.5.2 Data processing. Tendency analysis.*

4.2.1 Regression model vs. growth/decline rate evolution

Regression model. Justification

According to experimental data processed and tabulated in the section of *Central tendency estimator tables* in the *Appendix*, it's concluded that there is not enough data over time to perform a regression analysis with sufficient rigor and at the same time that the statistical inference made is sufficiently robust. Indeed, it has only four sampling time for each stage of the project and for each seedling, which affects the validity of any proposed regression models (linear models, polynomial, logarithmic).

Instead of making a regression model using only four interpolation points which would mean a mistake too rude because of the few data available, should be performed by analysis methodologies to more accurately capture of the behaviour of growth; said in another way, a methodology that appreciates the changes in growth trends due to seasonal effects (see *Figure 25*).

Conducting a linear regression model, can lead to biased results and conclusions, although it has the advantage of using a single parameter, the slope of the regression line, which can be understood as the average of the perish rate integrated over time, can easily synthesize general trend average growth of seedlings, though without considering seasonal effects but could be related with the seed size, independent to the amount of time considered in the analysis, the vegetation, the treatment and the seasonal effects.

Perish rate evolution model. Justification

For trend analysis will be performed in an analysis of the "first derivative" of the emergence over time, which can be observed the different "true experimental" growth rates of seedlings over time, and can make a value judgment about growth trends of each seedling according to the treatment performed.

The analysis of the first derivative can also get an idea of the best regression model that could be interpolated. In the case that the optimal regression model is a linear model, the differences between the growth rates observed for the same project and the same stage of plant variety should be zero or, at least, minimal, indicated this in a constant graphic or staggered small pieces with a magnitude between jumps. In fact, in the case of assuming a linear behaviour, the slope of this model continues to be a weighted average of the different rates of growth with which it's been working in this analysis (see *Figure 25*).

Proceeding through the analysis of the first derivative, it cannot be summarized the growth trend as a linear regression model could make, but instead provides less biased information on growth rates of seedlings for each time period considered, being therefore an indicator of growth trends more reliable, though valid only for each stage considered, since the derivative is intrinsic to the emergence of seedlings of each variety and depends on different assumptions about the regression model that may be established.

Thus it appears that the proposed methodology Perish rate in this project permits to capture seasonal effects on the different trends of seedling growth, while a simple regression model, forget this fact providing only an average value integrated over time.

Perish rate definition and procedure

According to that set out in the preceding paragraphs, shall be calculated the seedlings “growth/decline rate” as the first derivative of the time series of count of emerging seedlings for each treatment. Said derivative is calculated as the ratio between the difference of seedlings recorded in two successive counts, and the time interval between the corresponding counts.

$$e'(t_i) = \left| \frac{e(t_i) - e(t_{i-1})}{t_i - t_{i-1}} \right|$$

Where:

- t_i It's the instant time assessment, measured in weeks.
- $e(t_i)$ It's the emergence of seedlings at the moment of evaluation, measured in number of seedlings.
- $e'(t_i)$ It's the perish rate, expressed as the absolute value of the first derivative of seedling emergence in time for the moment of evaluation, measured in number of seedlings per week.

The perish rate thus defined, has units of number of seedlings per week, being therefore a perfectly valid indicator to study seedling growth trends over time. This analysis will be sufficient to compare growth trends of different plant varieties, as it's not statistically valid to establish regression models due to the lack of data that are available, as mentioned above.

Given that the role of emergency has been seen as a continuous piecewise linear function, due to the discrete data processing field, the resulting graph will be a consequently not continuous piecewise pieces.

4.2.2 Evolution graphs for each vegetal type

For each plant variety it's been attached the evolution graphic of the seedlings at the time, accompanied by its "first derivative" graphic or also known as growth rate, understanding growth rate as indicated in the *3.5.2 Data processing. Tendency analysis* section.

Performing together these two graphs is possible to analyse the different growth trends for each plant variety depending on the treatment made, according to the stage in question.

Several plots are attached with the valour of the growth rate, understood as the first derivative of the seedlings emergence, is to say, "minus perish rate", showing thus the mathematic and ecological process of plants growth.

Acacia acuminata plots

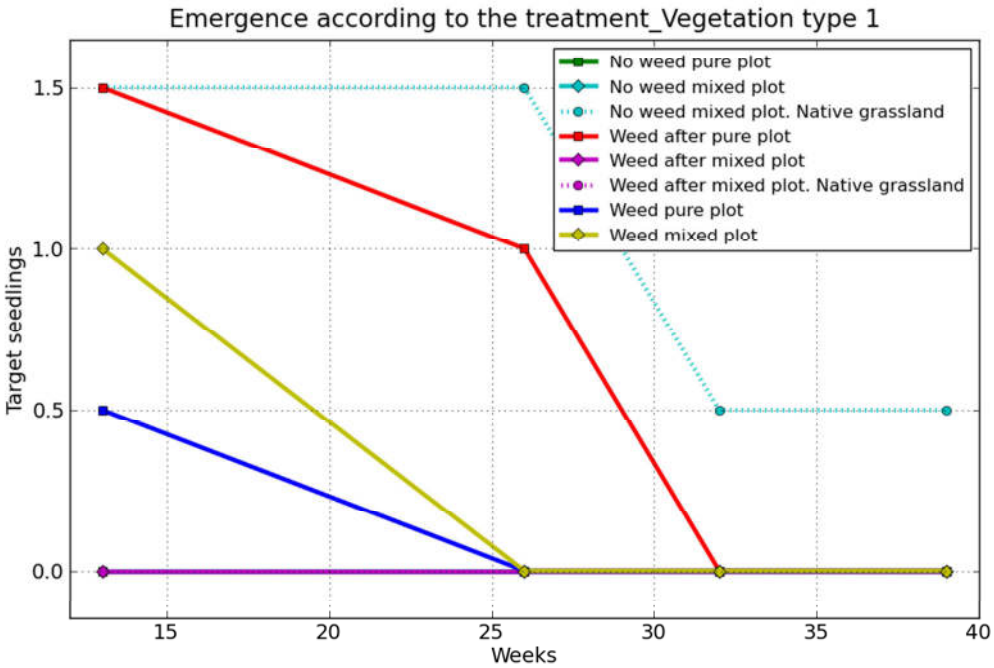


Figure 42. Emergence according to the treatment for *A. acuminata*

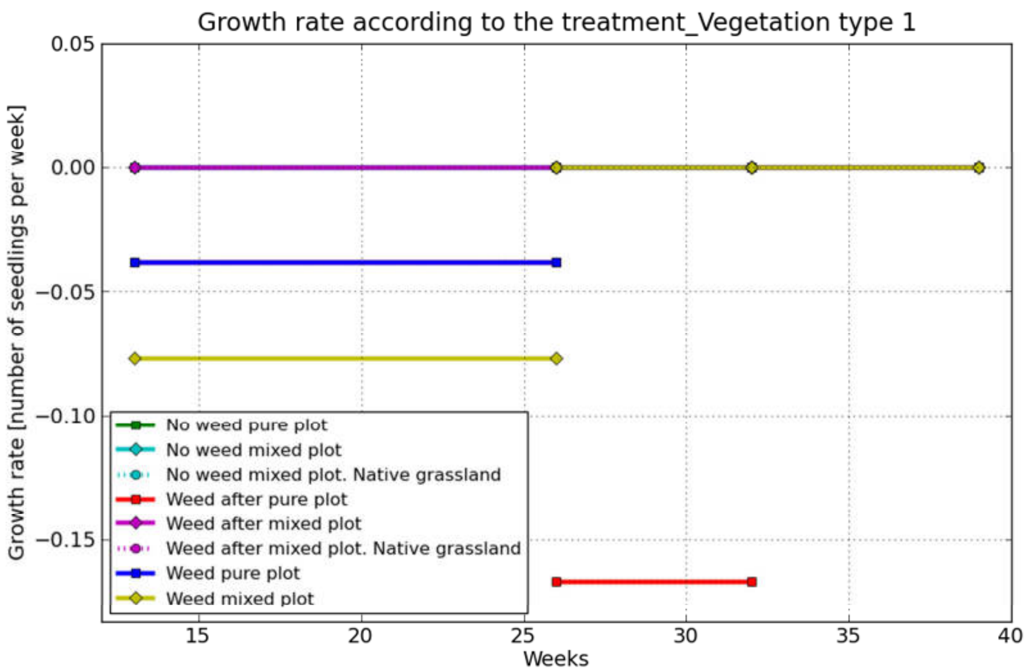


Figure 43. Growth rate according to the treatment for *A. acuminata*

Acacia pulchella plots

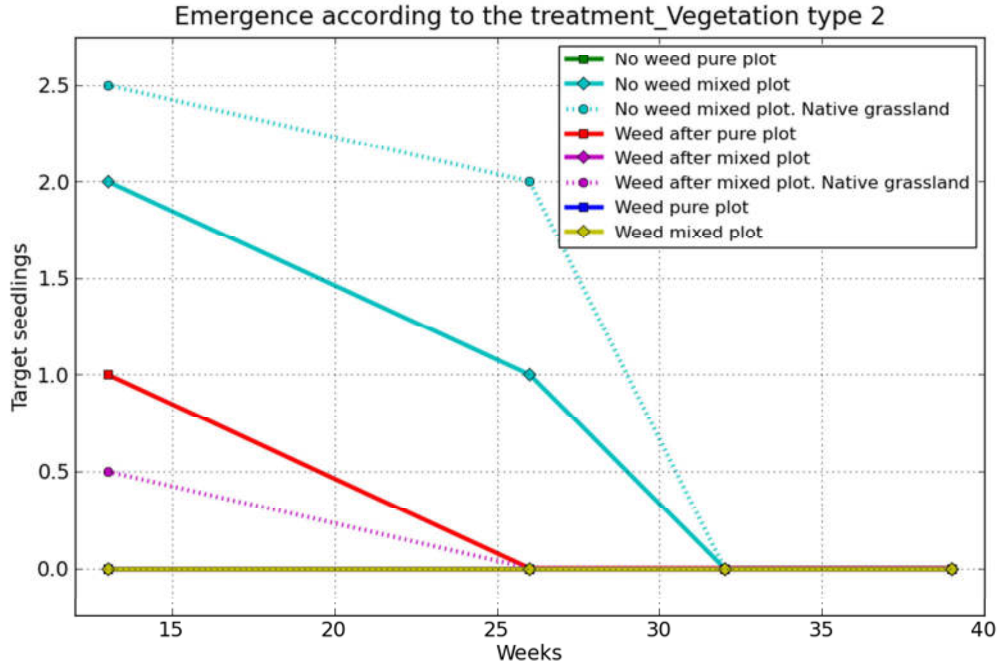


Figure 44. Emergence according to the treatment for *A. pulchella*

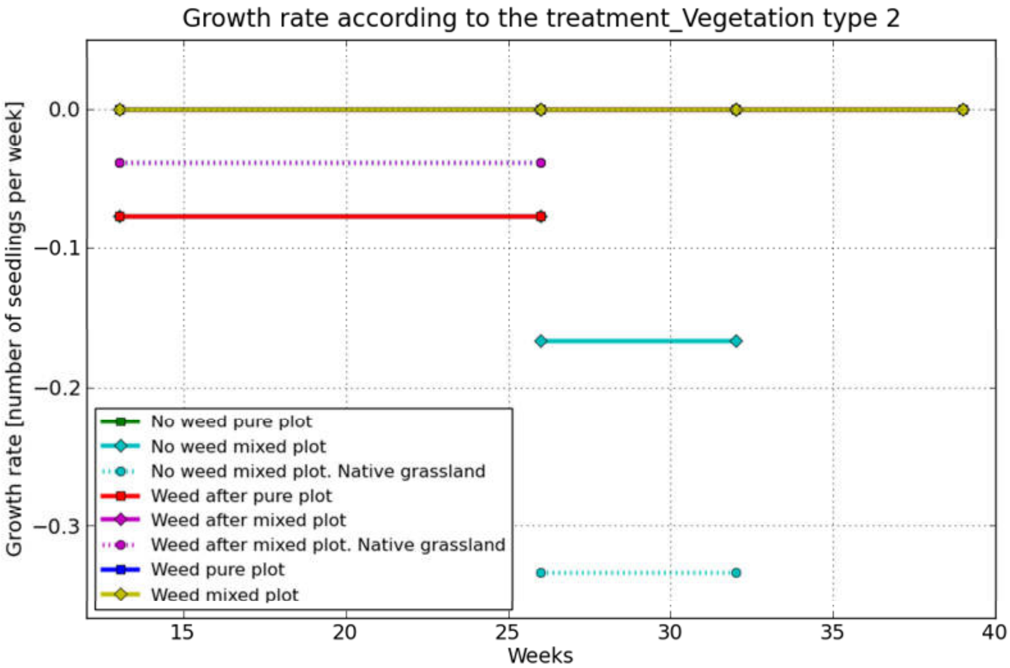


Figure 45. Growth rate according to the treatment for *A. pulchella*

Eucalyptus accedens plots

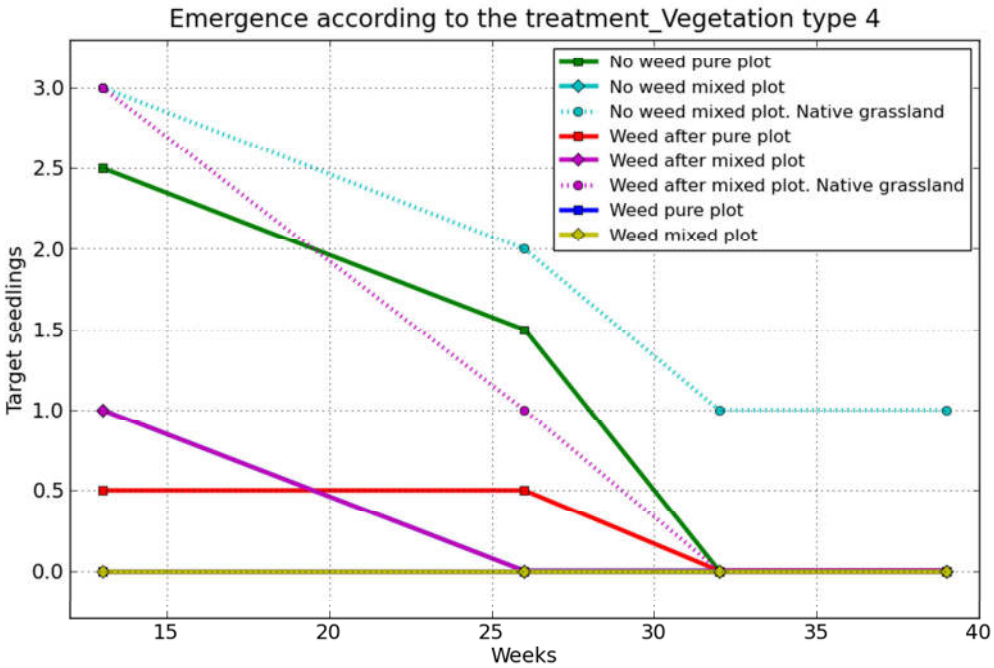


Figure 46. Emergence according to the treatment for *E. accedens*

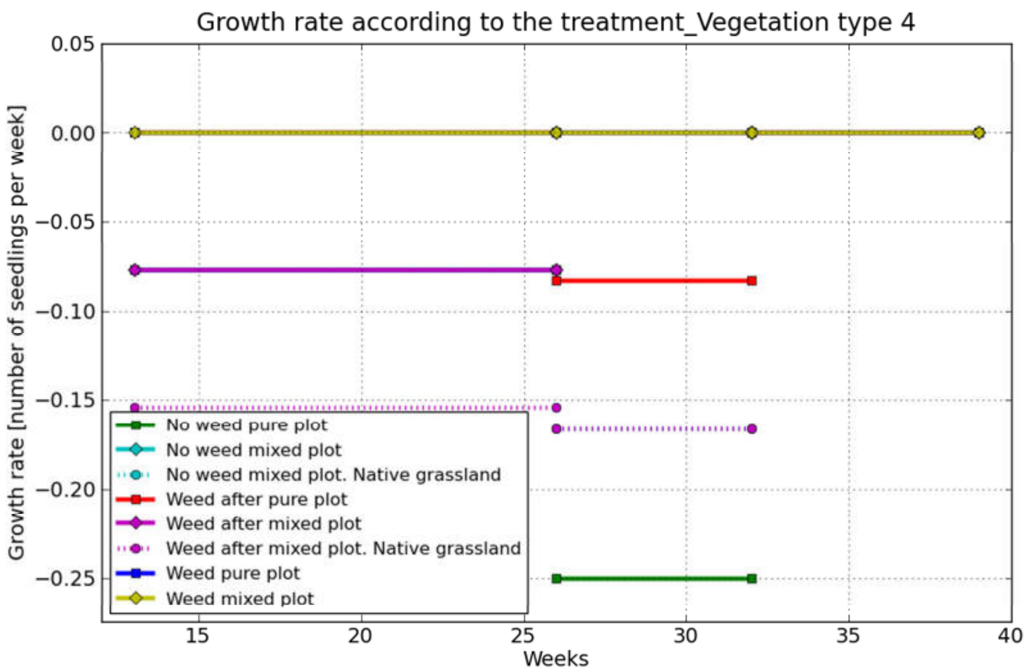


Figure 47. Growth rate according to the treatment for *E. accedens*

Eucalyptus astringens plots

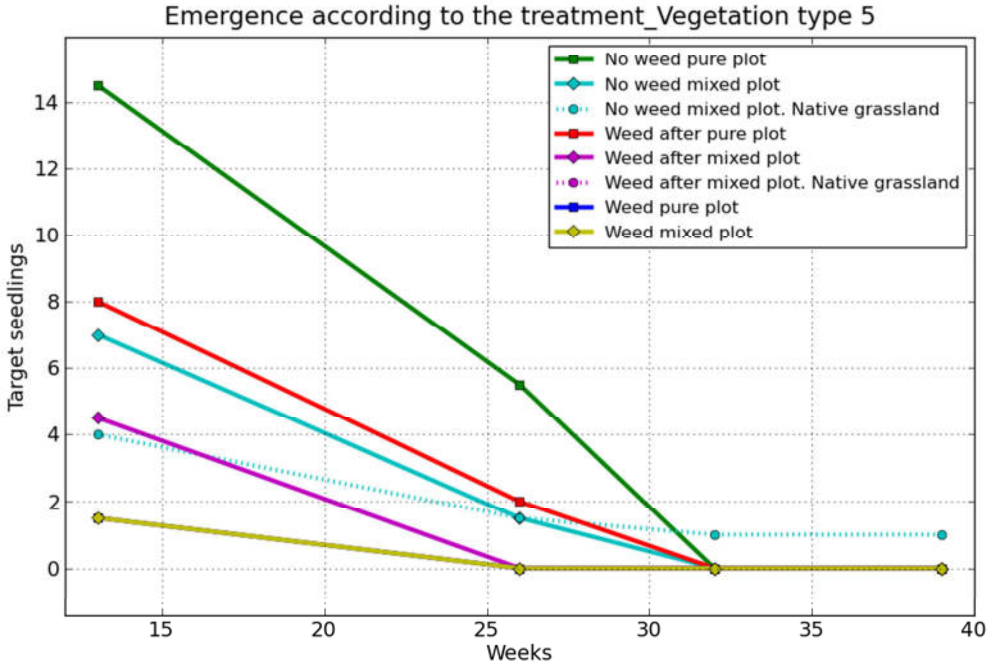


Figure 48. Emergence according to the treatment for *E. astringens*

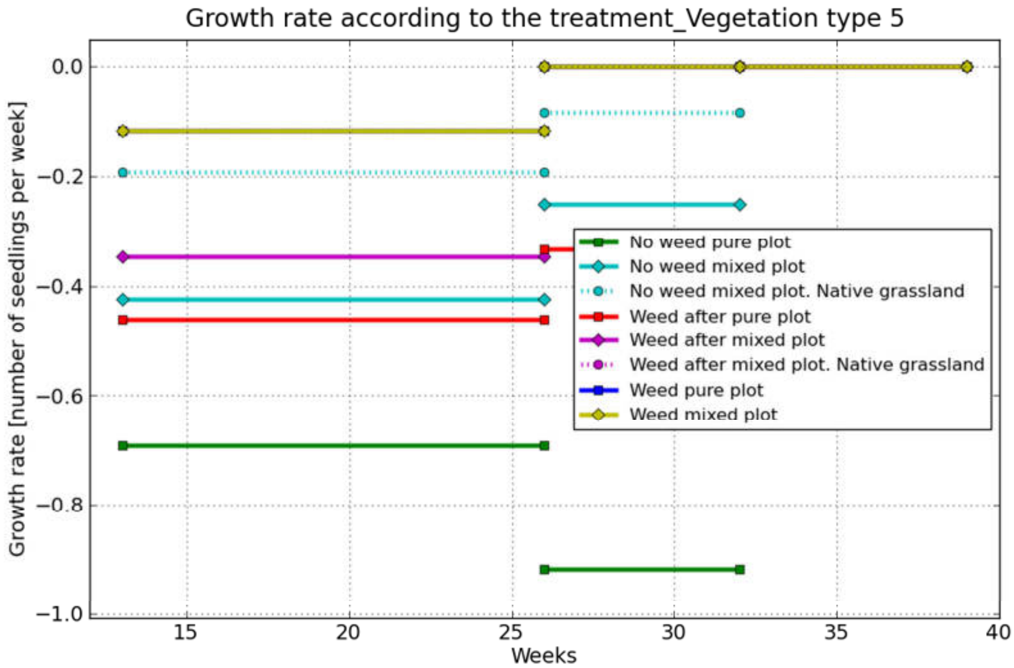


Figure 49. Growth rate according to the treatment for *E. astringens*

Eucalyptus loxophleba plots

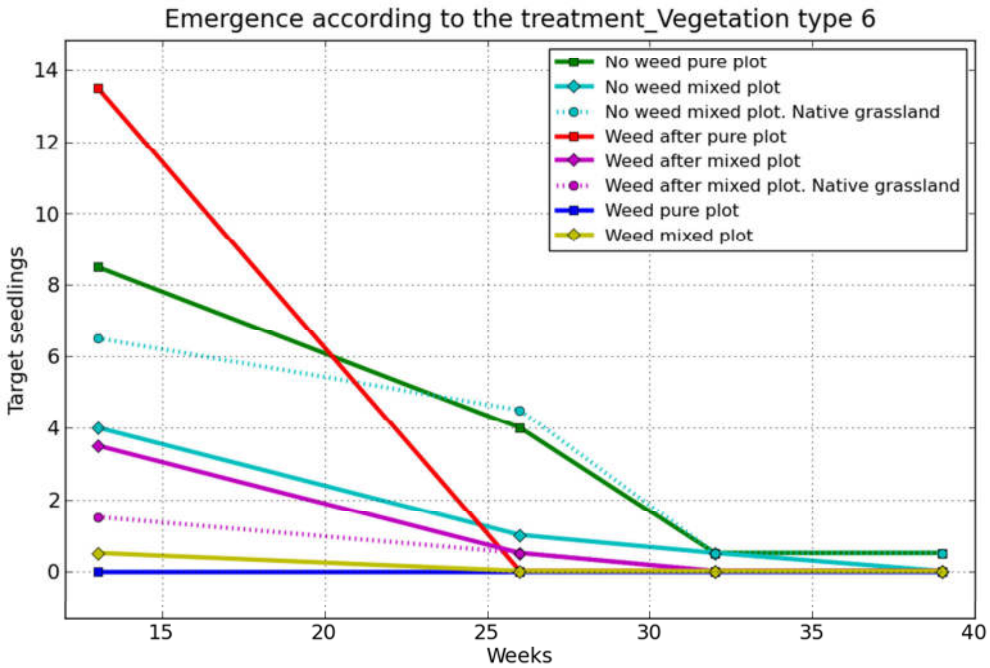


Figure 50. Emergence according to the treatment for *E. loxophleba*

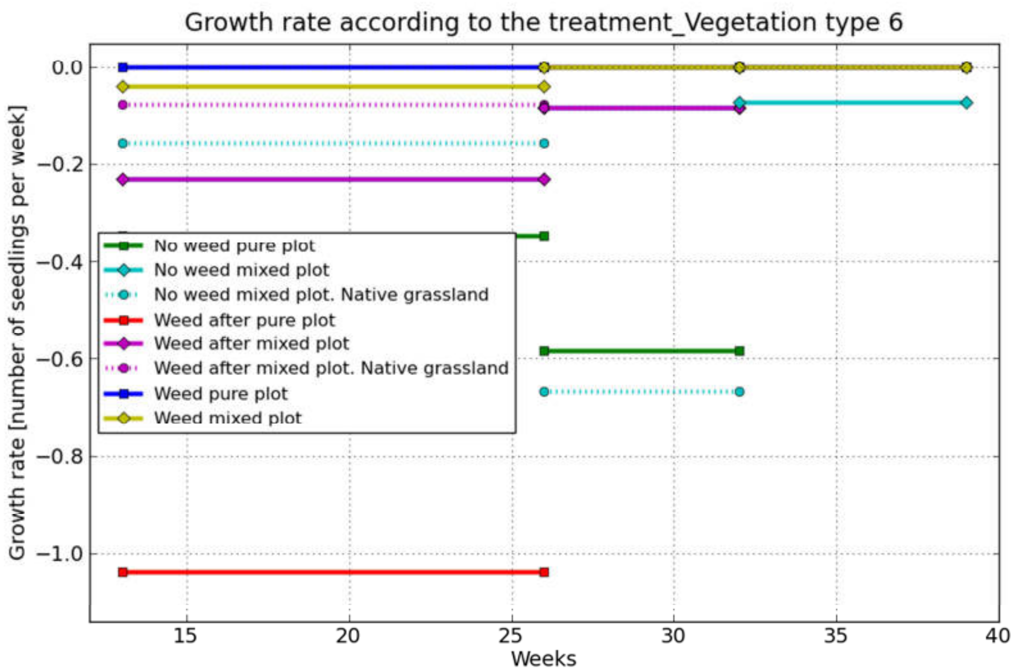


Figure 51. Growth rate according to the treatment for *E. loxophleba*

Austrodanthonia caespitosa plots

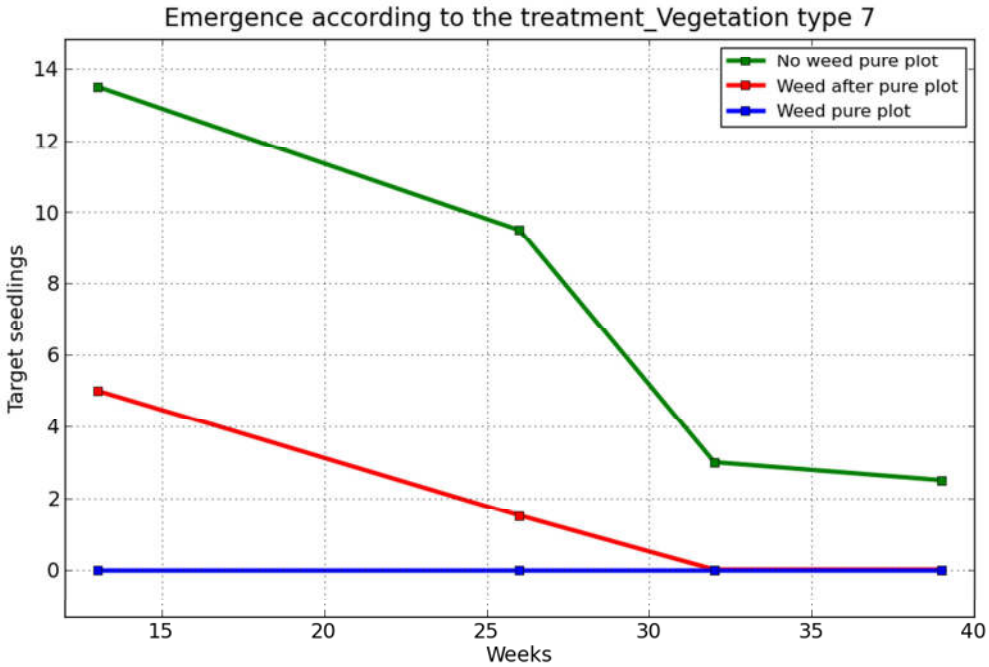


Figure 52. Emergence according to the treatment for *A. caespitosa*

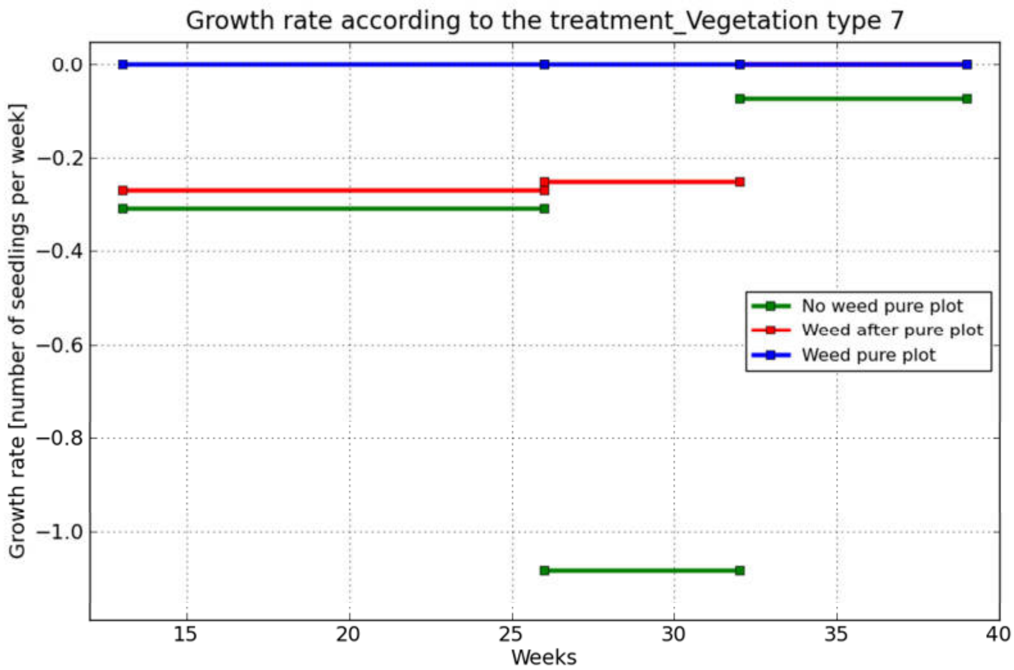


Figure 53. Growth rate according to the treatment for *A. caespitosa*

Comments about emergence

The results of *A. sesslis* have not been present for the null emergency.

By analysing the graphs, can be demonstrated differentiated behaviours in both acacia trees such as eucalyptus and native grass.

According to the acacia trees, there is a greater emergency in cases of Weed After treatment than in the Weed treatment, as may be apparent. In contrast to the cases of No Weed, the emergency has been null.

In reference to eucalyptus trees, there is a major emergency in case of No weed that not in the rest of the cases, such emergency being higher in the case of emergency contemplated in pure plots than in mixed plot, happening the same to the crops of native grass. In the particular case of *E. loxophleba*, it can be seen that in the first stage the largest emergency is in the scenario Weed after, but then in a second stage the emergency is higher over the scene not weed.

In the case of contemplate scenarios with coexistence of the native grass, at all times the emergence of the native grass is higher than the natives woody varieties in question.

Comments about growth tendency

Once analysed the graphs relating to the growth rate, clearly shown unequal mortality trends in two stages where the emergency has not been zero (stage 1 between weeks 13 and 26 and stage 2 between stages 26 and 32).

Can be suggested the following facts:

- In the case of the plant species *A. acuminata*, and *A. pulchella*, *E. accedens*, notes that the mortality rate in the second stage is higher than in the first stage. This fact can be either relative to the second stage because of the drier climate, and therefore the difficulty in obtaining water means that these varieties tend to die more quickly in the second stage not in the first stage.

- For varieties *E. astringens* and *E. loxophleba* it's observed that in the scenario NWP the mortality rate is higher in stage E2 than in the stage

E1. On the other hand, NWM and WAM scenarios presented lower mortality rates in the second stage, which at first, probably due to the long-term beneficial effect of fungus symbiosis, being these varieties of eucalyptus more resistant to the lack of water than the other plant varieties analysed.

4.2.3 Proceeding according to linear regression

There will be an analysis of linear regression for different plant varieties studied and for each stage of the project, indicating in each case the Pearson's correlation coefficient set (R^2 adjusted) indicator of the goodness of the linear fit in the case of performing an analysis with limited data. Also will be tabulated the value of the slope of the different regression lines, value indicative of the average growth rate, tables attached in the Appendix.

Once the regression models are done can be seen that the coefficient of goodness of fit (adjusted R^2) is between 0.9 and 0.55 in all cases except where the corresponding count is zero. This fact indicates that the adjustment with a linear model is good enough in some cases and not in others, because of that it develops the methodology of perish rates involving the derivatives of the emergence function.

Below will be indicated in a histogram the different average growth rates changed sign (average perish rates), covered by the different slope of linear regression models, which has units of seedlings/week in each scenario project depending on the plant variety. In this way it's intend to observe the different trends of growth of the seedlings through the methodology of the regression models, integrating over time the growth trend and synthesizing with a single value for seedling and scenario project.

These average of perish rate will be used to develop a correlation analysis where will be correlated the growth/decline rate and the seed size, as indicated in *3.5.2 Data processing. Tendency analysis and, Validation procedure section.*

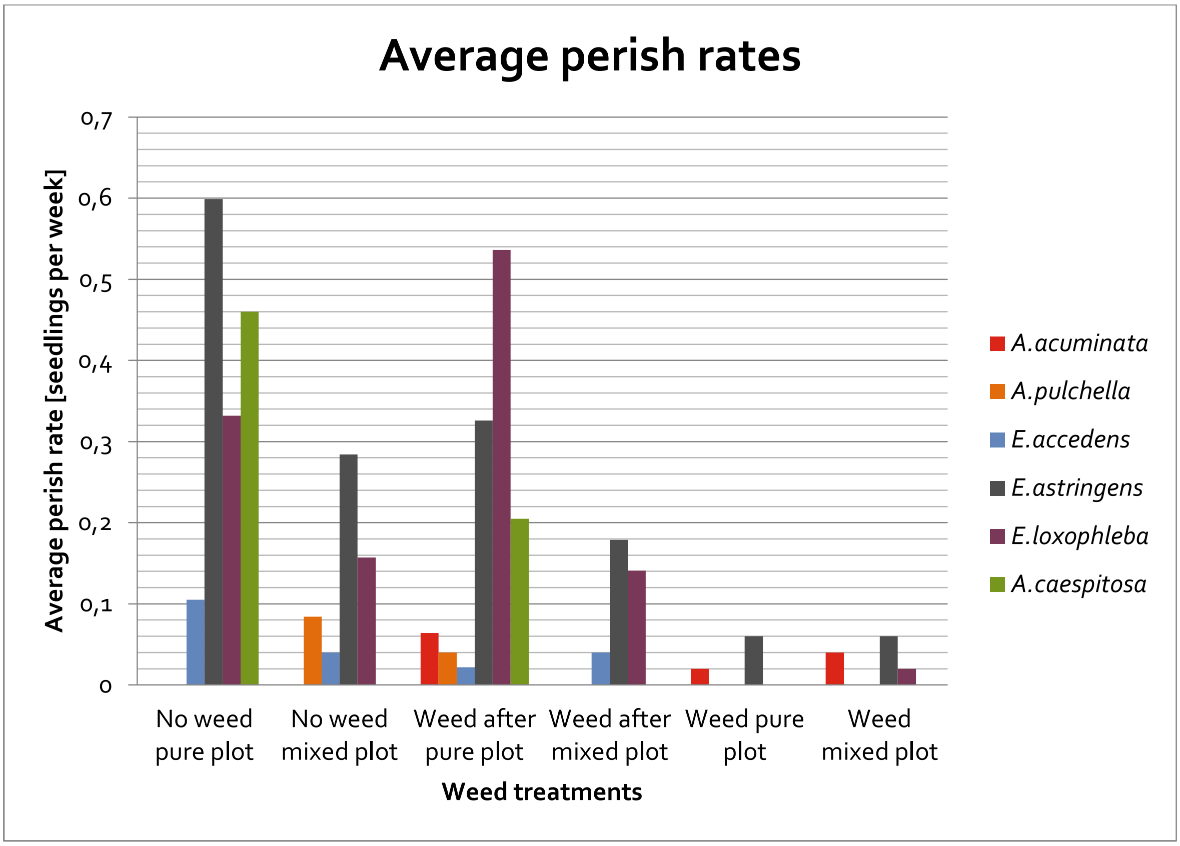


Figure 54. Average perish rates for a lineal regression

Analyzing perish rates, can be observed that assuming a model of linear growth in time, in pure plot mortality rates of plants are higher than in the case of mixed crops, except that in the case of treatments Weed, where these rates are similar.

It's also noted that in the case of No Weed, the *E. astringens* presented a great rate of reduction in populations in comparison to other scenarios, and on the contrary Weed After pure plots, the *E. loxophleba* have higher rates of mortality.

May be evident also the fact that mortality trends of *E. astringens*, *E. loxophleba* and *A. caespitosa* are substantially higher in scenarios of No Weed and Weed after than for the rest of species.

4.2.4 Proceeding according to growth rate evolution

Once analysed the graphics, as well as the goodness of the linear regression model for each seedling and for each stage of project, it can be said that the model of emergency along the linear time does not seem to be linear for all the scenarios listed, or at least, there are not sufficient data to make this assertion with forcefulness. In fact, analysing the charts of the emergence of seedlings, one could distinguish between three different behaviours in the three stages of study, being the stages: E1 (spring season) between week 13 and 26, E2 (summer season) between week 26 and 32 and E3 (autumn season) between week 32 and 39. Behaviours that can be explained due to the season of analysis for each stage in question, i.e. seasonal effects.

Spring stage analysis

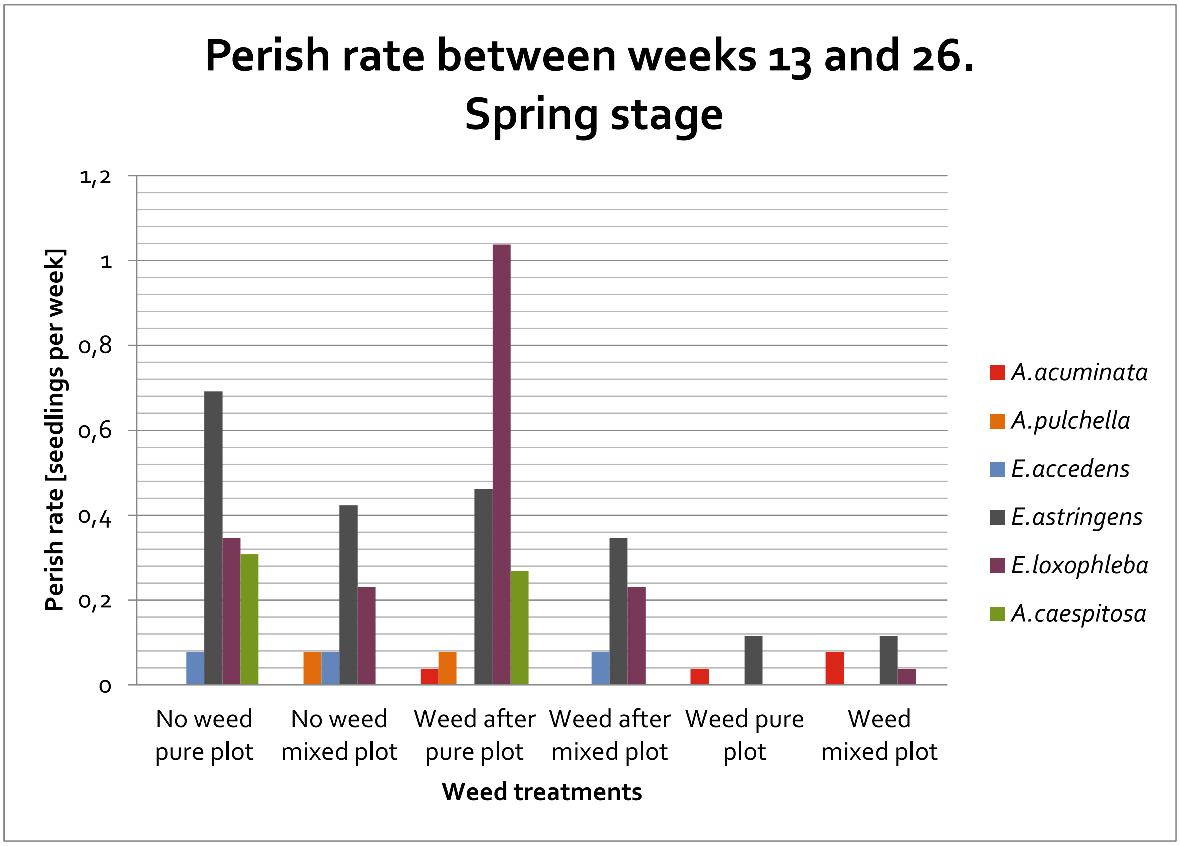


Figure 55. Perish rate in spring stage

Looking at the histogram of spring, it can be concluded that in general rules, the mortality rate of coexistence scenarios with native grass is lower than for native crops by the same treatment. The scenarios No Weed have higher mortality rates than the rest.

There is also a strong rate of mortality of *E. loxophleba* in the crops of WAP, being notorious the mortality rate of *E. astringens* and E. *loxophleba* above the others species. Aspect that may be related with the seeds size, 0.55 and 0.61 respectively.

Acacias however remain low mortality rates, less than 0.1 seedlings per week.

Summer stage analysis

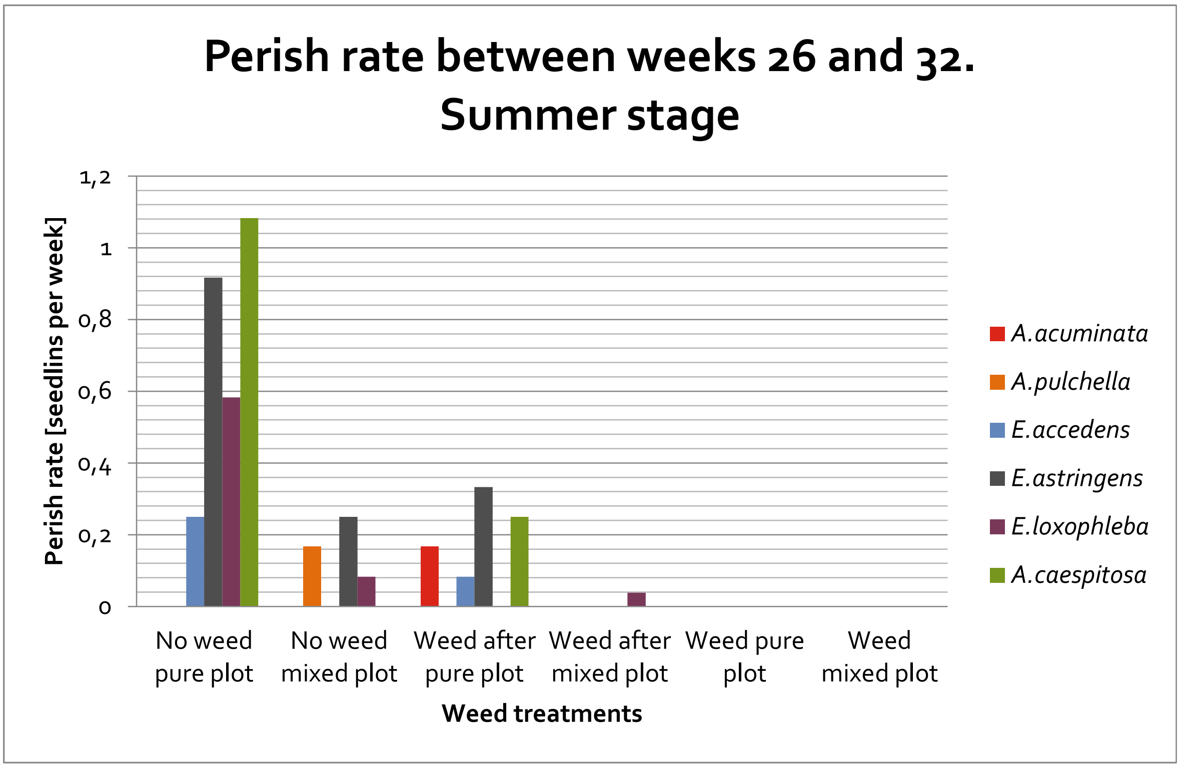


Figure 56. Perish rate for summer stage

In summer, if it's compared the magnitude of the mortality rates respect to autumn, there is a high mortality in the NWP crop varieties respect to the stage NWM which could be explained by the mycorrhized roots as beneficial reducing the mortality rate in the case of eucalyptus.

The scene WAP also presents moderate mortality rates in comparison to WAM scenario. WEP and WEM scenarios have zero mortality rates since the emergency in both scenarios is negligible for all varieties, cause around 32 weeks are already dead all the seedlings.

4.2.5 Discussion about the tendency evaluation procedure

Using the methodology of Perisher rates, captures better the behaviour of seedling growth, being able to carry out the analysis of trends for each seasonal stage in a more accurate way than using the slope of the regression as a benchmark indicator. Indeed, information is lost about the behaviour proceeding with the regression models if the linearity assumption is not valid, although the slope of the linear regression is an indicator of global trends is more synthetic.

In the absence of further experimental data, it was concluded that the growth trend analysis using the methodology perish rates is sufficient to analyse the growth of seedlings over time for the scenario in question, as it includes information similar to that provided with the methodology of regression models, in addition to providing the possibility to see different growth behaviours during the stages studied. Although the coefficients of goodness of fit of the linear models are not too bad, because the few data available to perform the interpolation, it's concluded that the best method to use in the case in question is the relative to the *perish rates procedure* developed in this project.

The findings set out on trends in the growth of the different plant varieties are similar proceeding with the raised two methodologies, although it prefers the methodology of growth rates because it has the potential to indicate the local developments of each stage, indicating more accurately the behaviour of the seedlings along the time (seasonal effects).

4.2.6 Discussion about the growth tendency results

In the graphs relating to each seedling presented in section *Evolution graphs for each vegetal type*, can be seen the trend growth/decline rate of each species depending on the treatment carried out. However, in the perish rate histograms for each stage can be seen the trend of local growth in each stage of the project according to the seedlings cultivated.

In the section *Evolution graphs for each vegetal type* in the *comments about growth tendency*, through growth rate could be established different conclusions about mortality of species. Analysed further comments, in general rules it seems that there are different growth/decline trends over time, effect certainly due to seasonal effects (PETER J. GROSE, 2013; E. JURADO and M. WESTOBY, 1999). It's also observed that the magnitude of the growth rates/decline is different for acacia and eucalyptus, suggesting a correlation between growth/decline rates and the seed size.

4.3 Survival index

For the project in question is defined survival as the ratio between the number of seedlings counted at a given moment of time and the number of seedlings counted to the established point of reference. This instant of reference established will coincide with the first count of emerging seedlings held in the second week of September (*first count of emergent plants*). Seen this point, the survival function is defined analytically as follows:

$$s(t_i) = 100 \cdot \frac{e(t_i)}{e(t_0)}$$

Where:

- t_i It's the instant of time for evaluation, measured in weeks.
- $e(t_i)$ It's the emergence of seedlings at the moment of evaluation time, measured in number of seedlings.
- $e(t_0)$ It's the emergence of seedlings in the instant of reference, being t_0 the 13rd week from the plantation, i.e. the *first count of emergent plants*
- $s(t_i)$ It's the survival rate expressed as a percentage, evaluated at the instant t_i

Once defined at the formal level the survival function, are carried out a series of graphs in order to assess the survival of the species depending on the treatment.

4.3.1 Survival graphs evolution and discussion

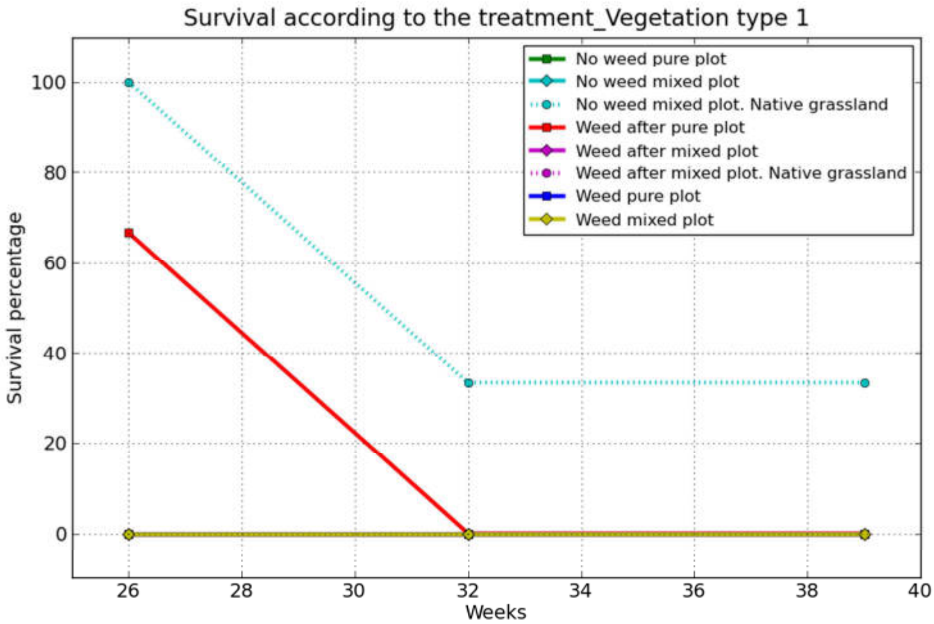


Figure 57. Survival according to the treatment for *A. acuminata*

In the week 26 survives only 63% of plantations in WEP while in the week 32 all the acacia has dead.

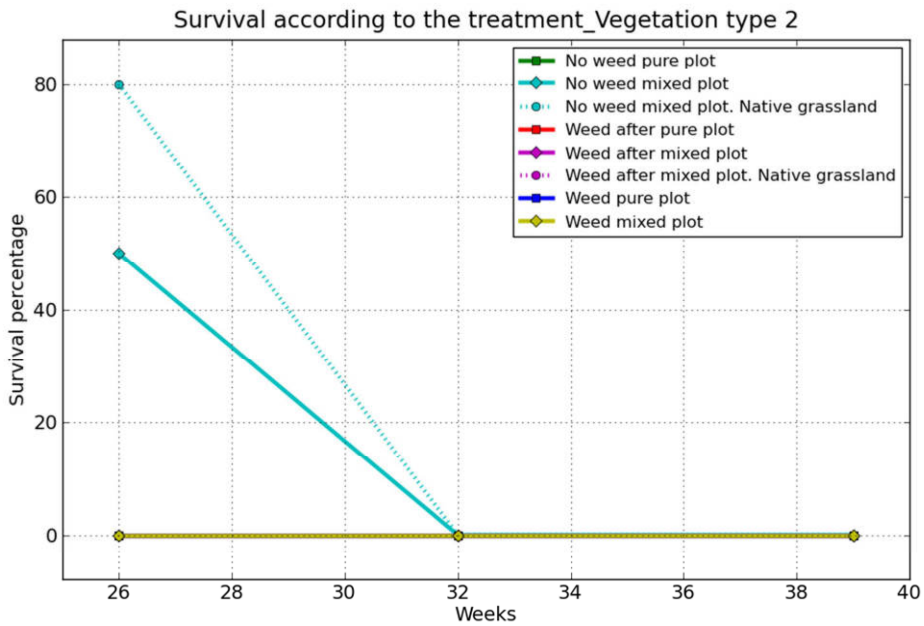


Figure 58. Survival according to the treatment for *A. pulchella*

At week 26, 50% survived in NWM scenario, thanks to fungus symbiosis and the no presence of weed while week 32 is dead everything. There is more native grass than woody specie for NWM.

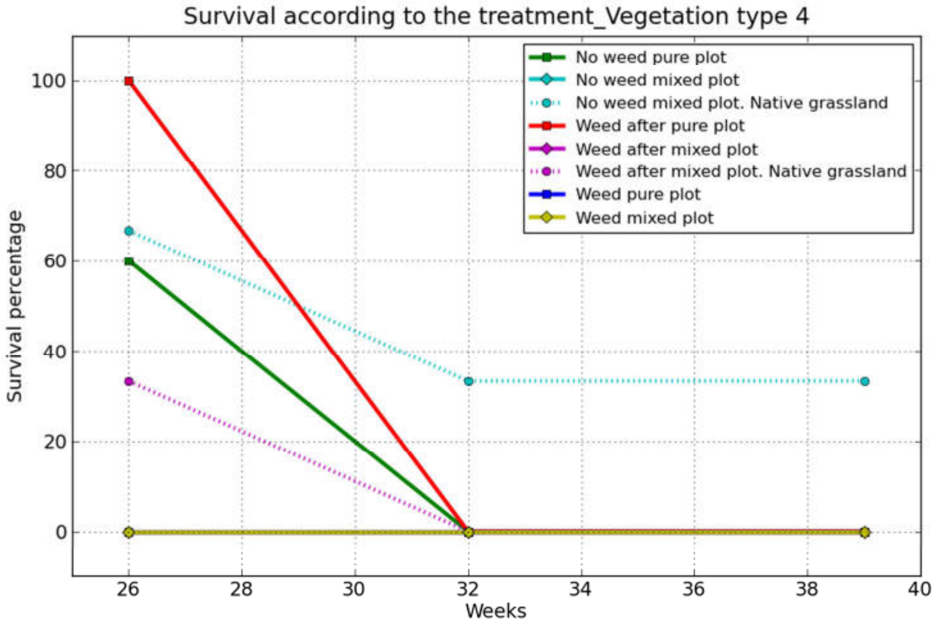


Figure 59. Survival according to the treatment for *E. accedens*

Scenarios NWP WAP have survivals exceeding 50% at week 26, whereas at the 32 week everything has died. Curious that NWP <WAP.

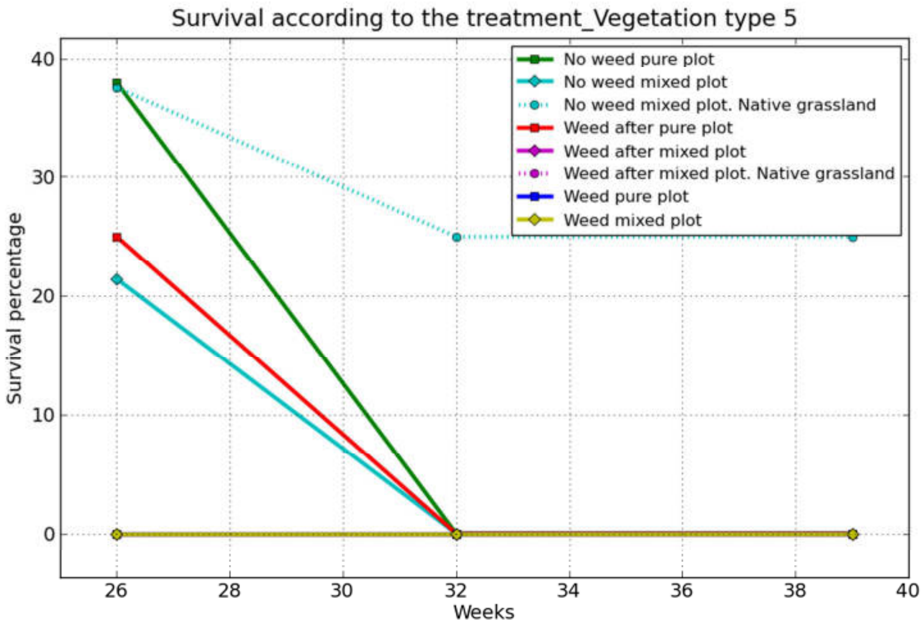


Figure 60. Survival according to the treatment for *E. astringens*

Increased survival in scenarios NW than in WA scenarios, but everything dies at week 32. More number of native grass in scenario NWM than the woody specie.

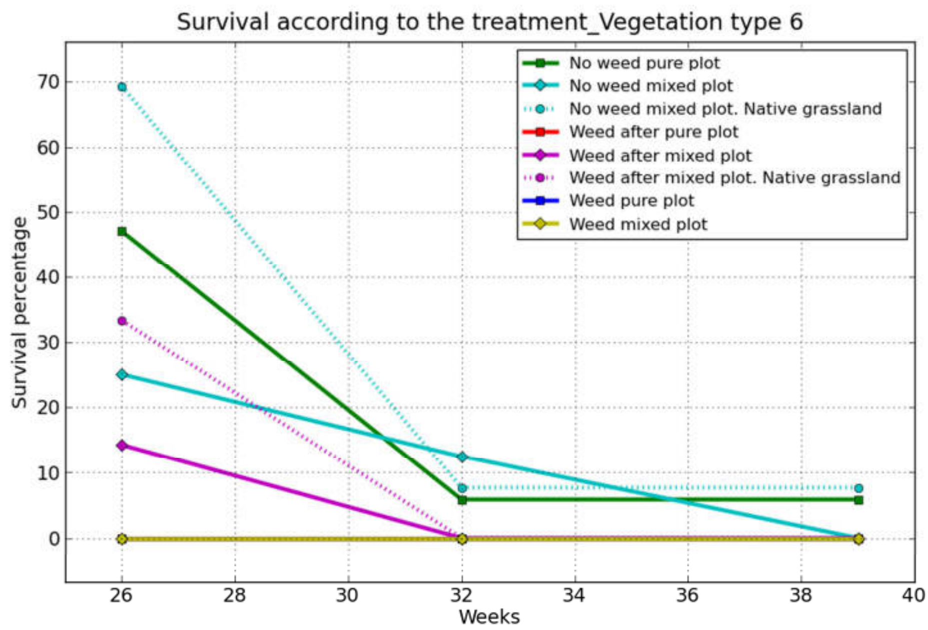


Figure 61. Survival according to the treatment for *E. loxophleba*

Greater survival scenarios in NW, not reaching to die all at harvest stage in NWP. More native grass in NWM and WAM than woody specie except at week 32 in NWM, although in harvest all the woody specie dies in NWM.

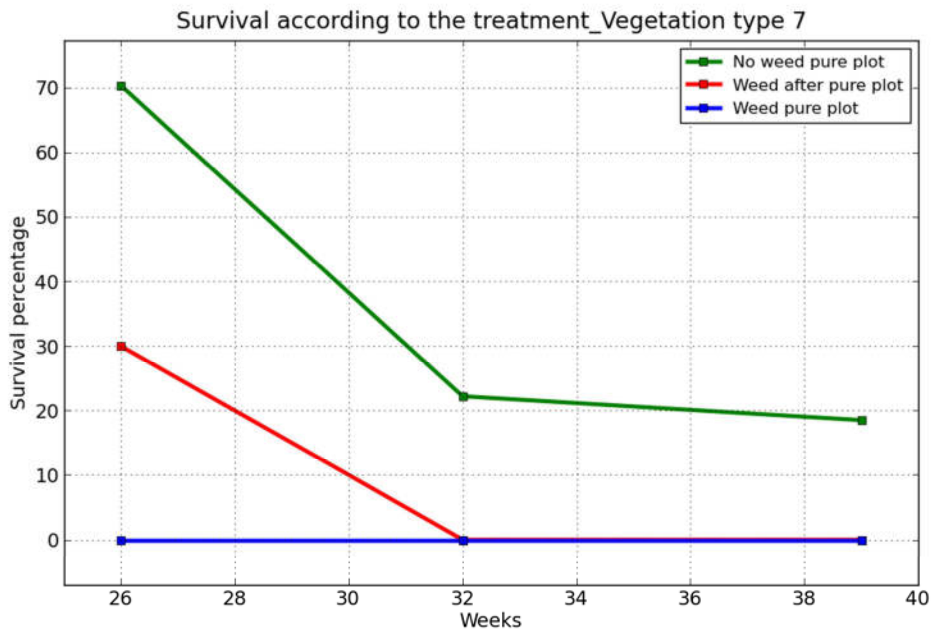


Figure 62. Survival according to the treatment for *A. caespitosa*

The native pasture NW scenario does not die at the end, being more resistant than in WA scenarios, logical because the weeds hinder the absorption of nutrients and therefore the survival in scenario WA has been nil.

4.3.2 Comparison between different survival of species and discussion

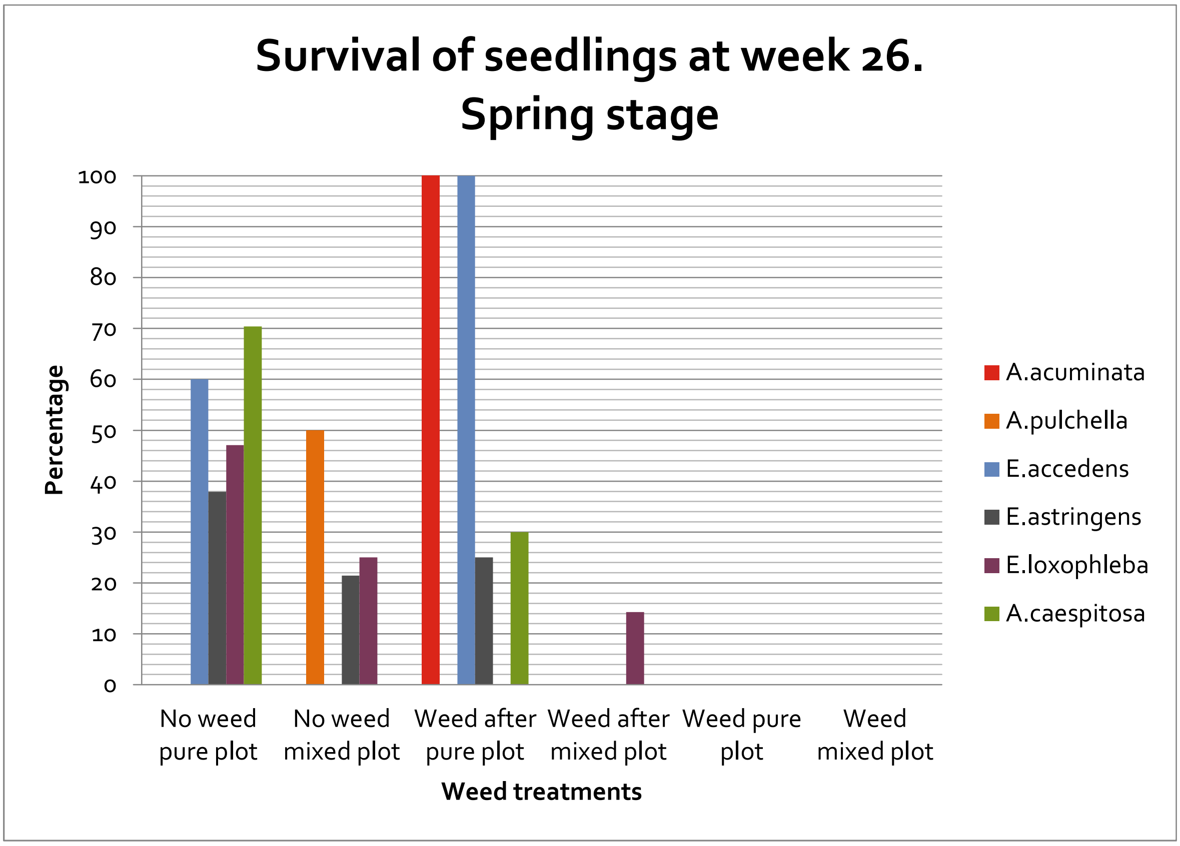


Figure 63. Survival of seedlings at spring

At week 26, the scenarios of NWP have higher survival of *E. astringens*, E. loxophleba and *A. caespitosa* that for other scenarios. In contrast, *A. acuminata* and *E. accedens* survival is greater in scenario WAP.

As curious information and as it can be seen in the graph, *A. pulchela* only survives in NWM and the only specie that survives in WAM is *E. loxophleba*.

In general there is more survival in pure scenarios than in mixed scenarios. It may be due to nutrient competition between the woody species and native grass, interspecific competition, this being worse than intraspecific competition, between the same species.

In WE scenarios, there are no survival plants; weeds prevent the growth of all varieties.

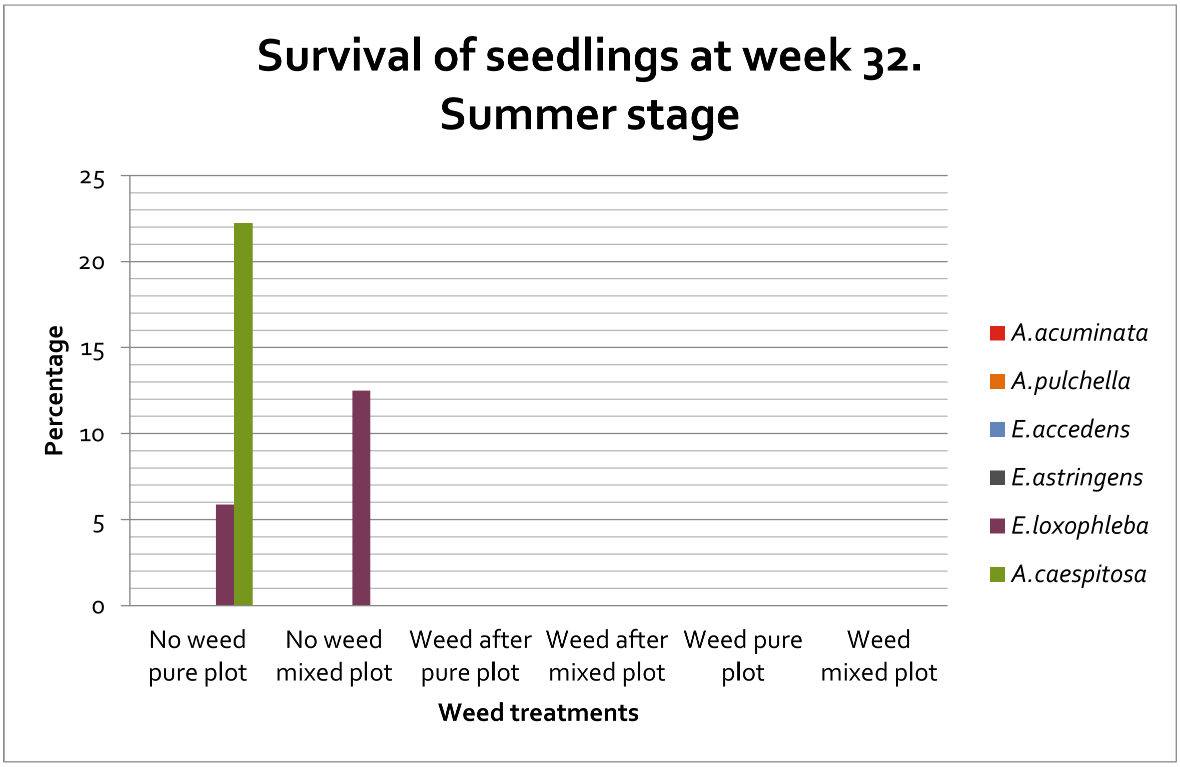


Figure 64. Survival of seedlings at summer stage

At week 32, there is only *E. loxophleba*, the more resistant variety, which only survives in NW treatment, being better when competing with native grass than when competition is intraspecific. One might think that the benefits of mycorrhizae in long term are greater or sufficient to eliminate the effect of competition for nutrients with native grass, in comparison to NWP scenario where survival is lower due to intraspecific competition. Even so, the variety survives at 32 weeks, with twice the number of plants found in the NWM treatment than in the NWP treatment.

At week 32, the native grass under WA has already died because of the appearance of the weed community and thus has hindered the development of the native grass. In contrast in the NWP treatment, the native grass is able to survive because it has any kind of competition.

All other species have died at 32 weeks in WA treatment because of the interspecific competence between the weed community and the woody species and the native grass. The lack of water in the soil will also be an influence factor.

In summary, the NWP treatment presents a higher survival rate at week 26 due to non-competition with weeds or the native grass to *E. astringens* and *E. accedens*. However, in the week 32 everything is dead except *E. loxophleba*, the variety most resistant of all analysed where long-term interspecific competition is more favourable for survival that intraspecific making the treatment NWM has twice the NWP seedlings.

4.4 Involved factors in Perish rates and survival index of seedlings

This section will try to relate different intrinsic parameters of each plant species with perish rates and survival that is able to develop each plant species.

4.4.1 Influence of the seed size in Perish rate

The previous part *3.2.2 Role of the seed size,* in *Chapter 3,* says that generally it's been found that species with larger seeds tend to have slower relative growth rates.

In this project it's used perish rate due to the mortality of the seedlings, as it's indicated in *4.2.2 Evolution graphs for each vegetal type*.

The acacias have lower perish rate in comparison with eucalyptus, being the seeds of acacias more heavy or large than the eucalyptus. It has been demonstrated a great difference in the behaviour between acacia and eucalyptus trees, especially in the perish rate (see *Figure* 56 and 57).

To corroborate the purposes of the sentencing stated in the previous paragraph, it's made a correlation analysis, as indicated in in *3.5.2 Validation procedure section.* This analysis will be carried out between seed size (expressed in weight of seed in mg) and the average growth rate (expressed as the slope of the linear regression model calculated in *4.2.3 Proceeding according to linear regression*) of each plant variety depending on the type of treatment. If the two variables are inversely correlated, the previous sentence shall be confirmed (see *Figure 26*).

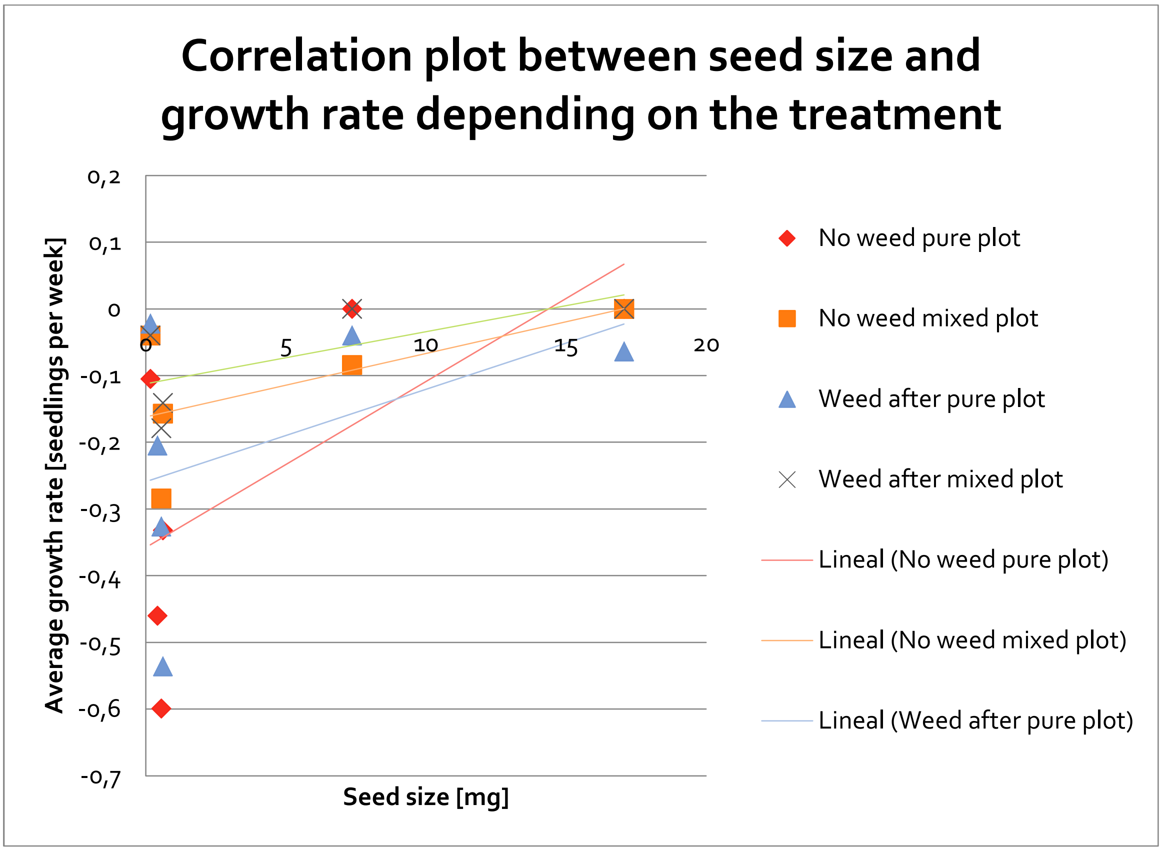


Figure 65. Correlation plot between seed size and growth rates depending on the treatment

Pearson correlation coefficient for variables: Seed size and Growth rate depending on the treatment				
Project scenario	NWP	NWM	WAP	WAM
Correlation coefficient ρ	0,67232141	0,62134894	0,46714794	0,68488083

Table 3. Pearson correlation coefficients between seed size and growth rates depending on the treatment

As it can be seen from the table, the Pearson correlation coefficient is positive in all stages of the project, using the average growth rate of the linear regression model. This correlation trend can also be demonstrated by analysing visually the slopes of the different regression lines that have been interpolated in the dispersion graph (see *Figure* 66), where the trend is always positive. As it's explained before, it's assumed in this project that perish rate it's the same that "minus growth rate". Therefore it will indicate that, effectively, exists an inverse relation between the perish rate and seed size variables, been a moderated relation ($\rho \approx 0.6$). Fact evidenced with a positive value of the slope of the linear models developed in *Figure* 66

Could be demonstrated in the experiment developed in this project the same result reached by (SALISBURY, 1942; GXIME and JEFFREY, 1965; SILVERTOWN, 1981; ATKINSON, 1972),, thus confirming the sentence where the species with larger seeds tend to have relative slower growth/decline rates regardless of treatment performed, the vegetal type, the possible seasonal effects, and the amount of time considered in the experiment.

It's relationship could be explained due to the greater reserves in large seeds, and their greater ability to quickly establish larger root systems (SANCHEZ-GOMEZ et al., 2006). BAKER (1972) observed that species in drier habitats on average had larger seeds, which could be interpreted as a hedge against water stress.

4.4.2 Fungus symbiosis influence in Survival index

In the survival, one could say that the mycorrhized roots provide long-term benefits, as you may think what has happened with *E. loxophleba*, although in short-term may be due to other factors as seed size, seasonal effects… This fact is not evident if we analyse the graphs attached in the following section.

4.4.3 Influence of Seasonal effects and weed competition in Survival index

In the survival of the species there is an aspect that noticeably impacts, the season. The season influences the degree of soil moisture because the weather of each season presents different temperatures and rainfall affecting therefore to the soil of the different plots. The study began with the planting of the seeds at the end of June, belonging to the Australian winter, and ended with the harvest in March, which coincides with the autumn. It has been able to verify that in autumn the moisture has been virtually non-existent as it will be reflected in the boxplots that will be presented below.

Another parameter that directly influences the soil moisture is the presence of weeds as they help to reduce soil moisture, on the understanding that they also require water to survive.

There will be a boxplot evolution of moisture over time for each stage of the project, were graphs are attached in Appendix section. Analysing this graphs, one can get some conclusion as to justify the non-linear behaviour of seedlings growth, and therefore, giving more validity to the method of Perish rates.

It will also carry out a correlation analysis between soil moisture and survival rate, aiming to demonstrate the strong correlation between these two factors.

Analysing the different graphs, the seasonal effect can be demonstrated in the moisture measurements carried out.

Two measurements were made of soil moisture in two distinct stages:

- First measurements made in week 17, the spring season, indicated in the preceding graphic _1.
- Second measurement made at 30 weeks in the summer season, indicated in the preceding graphic _2.

It can be seen from the graphs that soil moisture is null in the summer season in all scenarios considered for each plant variety. However, moisture is non-zero in the count of spring. This fact in itself should make a difference in seedling growth, which has been demonstrated experimentally by analysing on the one hand, the decline in the survival rate in summer compared to the spring, and on the other hand a change in the mortality rates observed in the E2 stage.

It's made a histogram indicating the moisture of each variety depending on the treatment plant performed for the spring season. The estimator used to perform said histogram is the median of the different soil's moisture measurements, according to the established in section *4.1.4 Data exploration*.

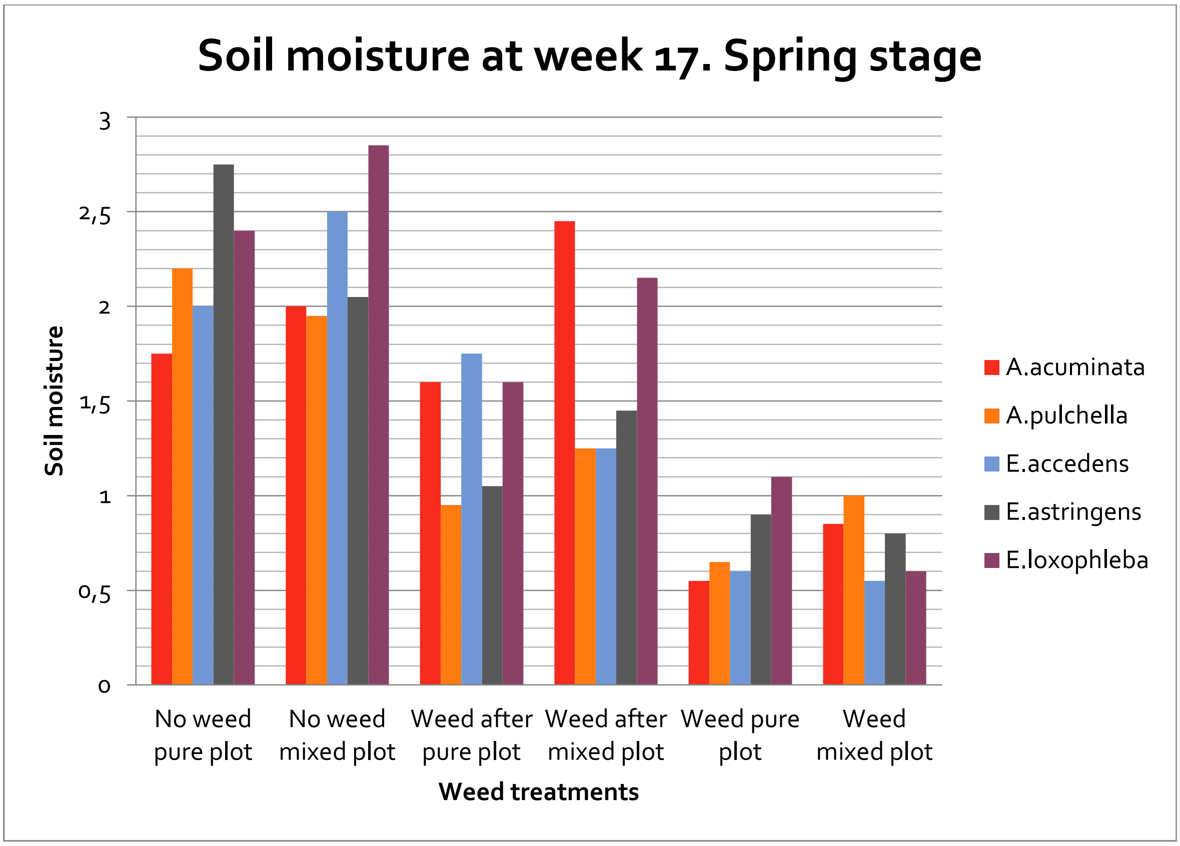


Figure 66. Soil moisture at spring stage

Analysing this graph can be drawn the following evidence:

- It has gained more moisture in the treatments No weed and the moisture decreases as weeds appear in time. This fact is explained due to the consumption of water of the weeds, adversely affecting the soil moisture of the plots in question, becoming in the case of Weed 1/3 compared to the moisture from the scenario No weed.

- There are no significant differences in the soil moisture content when comparing pure and mixed crops.

- Seems that the plots of the variety *E. loxophleba* had more soil moisture than other varieties regardless of treatment. This may be one of the reasons that this variety is the greatest survival, characterizing a resistance of the variety in conditions of competition with weed and with native grass. For *E. astringens* notes a similar behaviour as described at this point.

- Concerning the acacias, scenarios NW and WE presented similar humidity for each project stage, however, in setting WA, the humidity measured for *A.*

acuminata is almost double that for *A. pulchella*, enabling the survival of *A. acuminata* is 100% in comparison the *A. pulchella*'s, which has zero survival scenarios in WA (see *Figure* 64).

In conclusion, the presence of weeds acts decreasing soil moisture by up to a third compared to scenarios NW, affecting this fact to the survival of the species in terms of competition for the acquisition of water and nutrients. (See *Figure* 72)

The seasonal variation influences substantially in the reduction of soil moisture, dramatically influencing the survival of the species, being the species more resistant and in coexistence with native grass those that presented survival in summer (case of *E. loxplheba* in scenarios NW) (see *Figure* 65 and 72).

Correlation analysis between soil moisture and survival index

The rate of soil moisture is a key parameter for the survival of any plant species. In effect, the reduction of water in the soil, the chances of survival and proliferation of plant species decreases. This evidence of the nature seeks to confirm experimentally in this project through a correlation analysis of the two factors depending on the plant variety.

Correlation coefficient for variables: Soil moisture and survival index depending on the vegetal type. Week 26					
Project scenario	*A. acuminata*	*A. pulchella*	*E. astringens*	*E. accedens*	*E. loxophleba*
Correlation coefficient ρ	0,04579286	0,49487535	0,38023744	0,76745042	0,761583

Table 4. Correlation analysis for soil moisture and survival index. Vegetal type dependence for week 26.

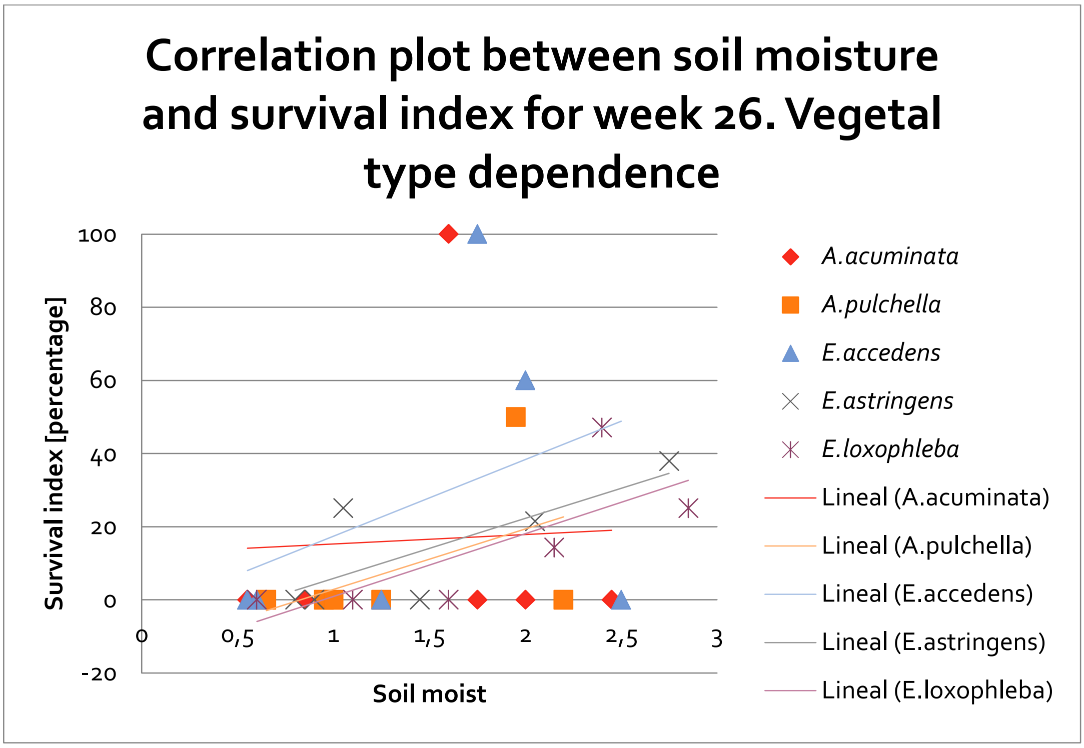


Figure 67. Correlation plot between soil moist and survival index depending on the vegetal type for week 26

Analysing the graph together with the table of correlations is evident that as the soil moisture increases, the expected survival of each plant species does it too. Both correlation coefficients (all positive) and the different slopes of the regression lines interpolated in the scatter plot (positive slopes) mark this direct dependence between the two factors, exposing clear evidence of the nature.

In the case of measurements of moisture for the week 30, corresponding to summer, these have been non-existent, being similar behaviour observed in survival for the same period of study. The varieties more resistant to the lack of moisture in the soil are the ones that have been able to survive in the summer season (as in the case of *E. loxophleba*).

4.5 Synthetizing results

On the basis of the various relevant graphs made in this project has been carried out a composition of the same, pretending to show on a visual level of an easy way and joint, the parameters that define the behaviour of the different seedlings over time for each stage of the project.

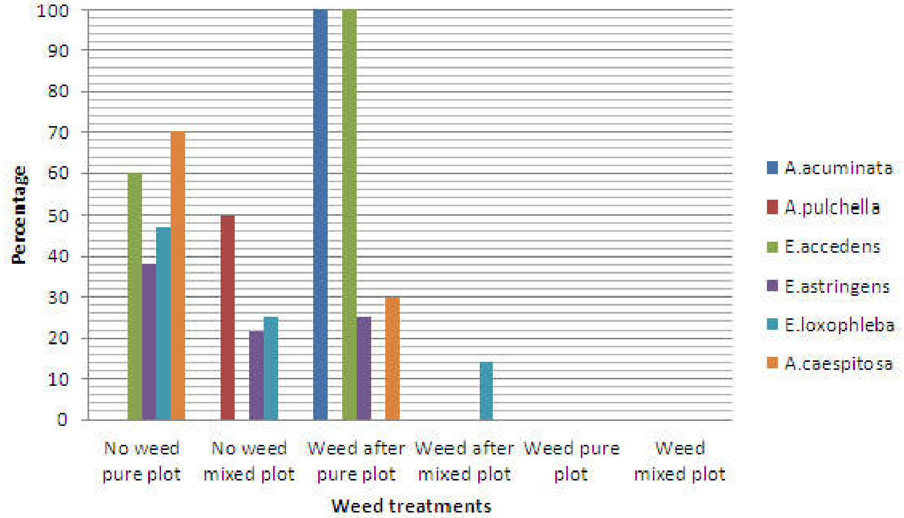
Is attached in a summary table in A3 that composition of graphics, where can be demonstrated the different conclusions that have been exposed throughout the different sections of this chapter, trying to interact with this document and be able to see clearly the differences and the general traits.

In the table are attached graphics relating to Perish rates and Survival rate for the seasons of spring and summer, being easy to interpret and interact according to the matrix format submitted.

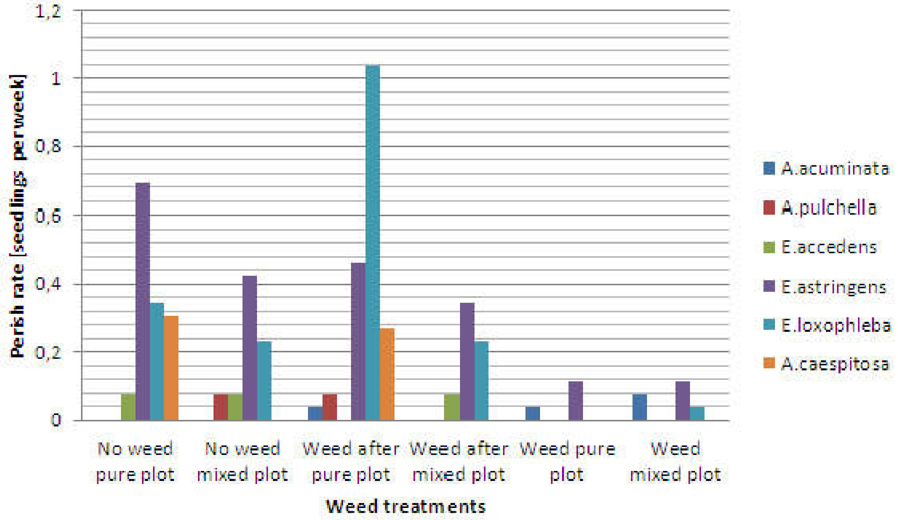
It’s also presented a graph of soil moisture in spring, not accompanied by the relative in summer because the humidity measured at this stage is null. Finally attached is the scatter graph between seed size and average growth rate, where may be evident the positive correlation regardless of the treatment provided and the plant variety. These two graphs try to explain how these parameters influence the rate of seedling growth and the survival in the same.

MAIN CHARACTERISTIC GRAPHICS

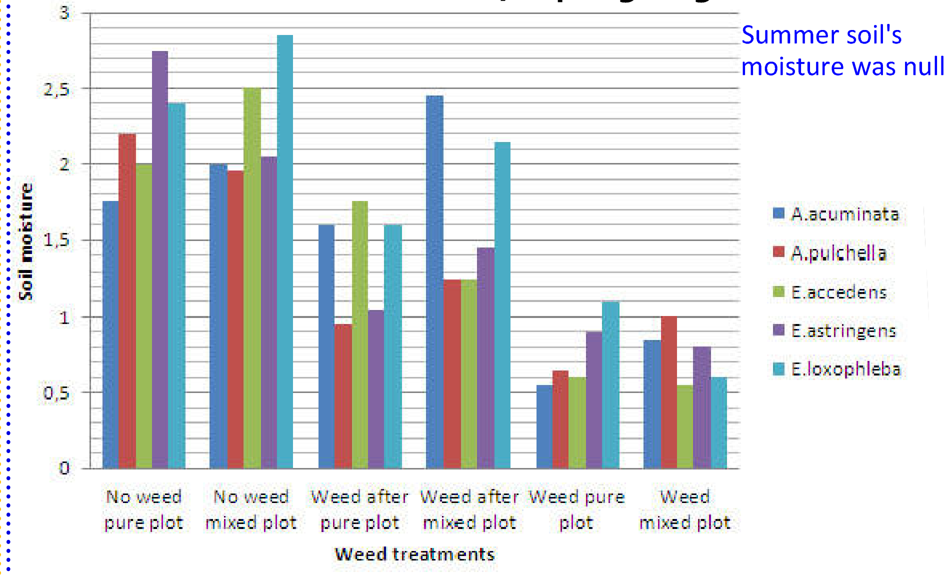
Survival of seedlings at week 26. Spring stage



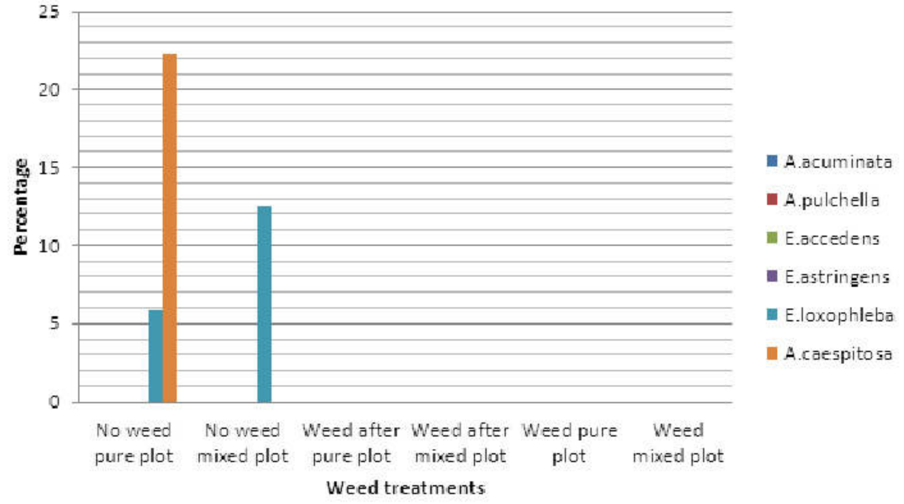
Perish rate beween weeks 13 and 26. Spring stage



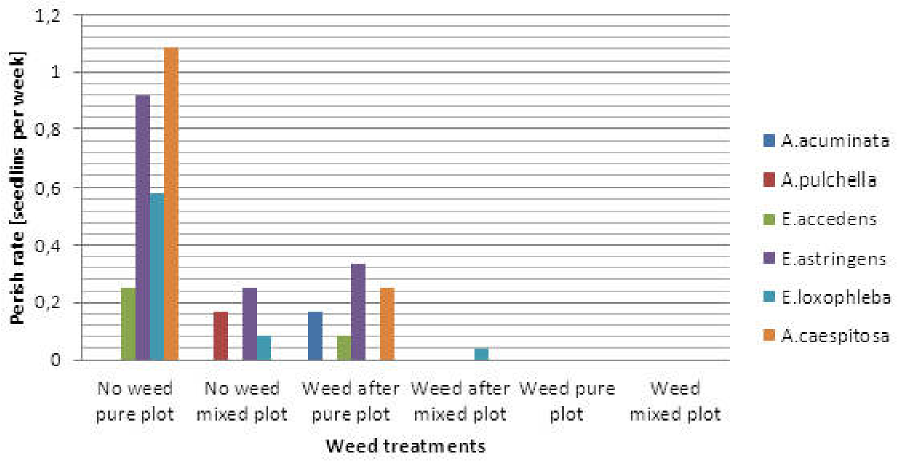
Soil moisture at week 17. Spring stage



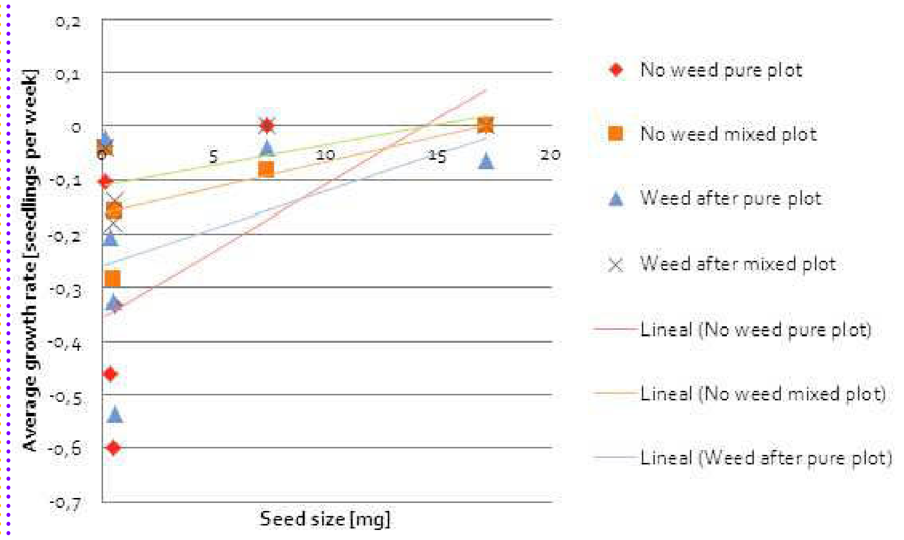
Survival of seedlings at week 32. Summer stage



Perish rate beween weeks 26 and 32. Summer stage



Correlation plot beween seed side and growth rate depending on the treatment



September 2013
Paula Buenaventura Martinez

CHAPTER 5. CONCLUSIONS

Below are the different conclusions drawn from the analysis and discussion of the results obtained in the project, which aim to answer the various questions addressed by the project (see section *Purpose* from *CHAPTER 1*). Categorization is performed to clarify and differentiate the diverse conclusions.

Conclusions concerning the experiment

- The data collected in the field have been appropriate and sufficient to achieve the purpose of the experiment.

- The size of the sample of the different variables referred to is reduced. This has an impact on the validity of the conclusions made; still need more reproductions of experiments for which the conclusions made are sufficiently reliable.

Conclusions relating to the statistical models developed

- Seedling populations do not follow a normal distribution pattern in the different plots.

- There is insufficient data to honestly say that the seedling emergence follows a linear model.

- Is better the model of perish rate developed in this project, than the linear regression to assess the trend of seedlings growth, as in this way can be included the effect of seasonality.

Conclusions concerning the trend of perish of seedlings

- The acacias have lower death rates than observed in eucalyptus, due to the fact of the role of the seed size, where other authors achieved to the conclusion: generally it's been found that species with larger seeds trend to have slower relative growth rates.

- Observed mortality rates higher in summer than in spring for the varieties of acacias and *Eucalyptus accedens*. The lack of moisture in the soil triggers the decreased speed in seedlings.

- For the varieties and *Eucalyptus astringens* and *Eucalyptus loxophleba* notes that in the scenario NWP the perish rate is higher in the stage E2 than in the E1. On the contrary, NWM and WAM scenarios presented lower death rates in second stage than in first stage, probably due to the beneficial effect of long-term of the mycorrhized roots, being at the same time these varieties of eucalyptus more resistant to the lack of water that the other plant varieties analysed.

- The timing of mortality in NW and WA scenarios with native grass is lower than in the case of pure plots, probably due to the effect of mycorrhized roots in eucalyptus trees.

Conclusions relating to the survival of seedlings

- If the plant variety is resistant to the cohabitation with weeds and has not died in the short term, in a long-term the coexistence with native grass results beneficial, giving higher survival rates as it has been observed with *Eucalyptus loxophleba*.

- In scenarios with Weed, the competition for the acquisition of nutrients is very strong and does not survive anyone. Weed remaining soil moisture getting to the point where the survival is null.

- NW scenarios have higher soil moisture and consequently higher survival than the other scenarios.

- In scenarios with WA, survival is lower than in NW scenarios due to the non-competition with weeds, although the *Acacia acuminata* survives better in the short term in WA than in NW.

- In general, in short term, the varieties die in mixed scenarios with weeds because of nutrient competition, as has happened with *Eucalyptus astringens* and *Eucalyptus accendens*.

- NW scenarios have more humidity in the soil and consequently greater survival than the rest of scenarios.

Conclusions relating to the analysis of correlation developed

- The size of the seed and the perish rate of the plant varieties present a relationship with a moderate inverse correlation, regardless of the type of treatment and the plant variety studied. Through the experiment carried out has been evident this fact, the result to which also have arrived at other authors (SALISBURY, 1942; GXIME and JEFFREY, 1965; SILVERTOWN, 1981; ATKINSON, 1972).

- Soil moisture and the survival index are two parameters directly correlated, which could be contrasted in the experiment carried out in the project in question, despite the evidence of this fact.

Conclusions regarding the presence of weeds

- The presence of weeds, especially in scenarios Weed notably affects the growth of different plant varieties, as competition for the acquisition of soil nutrients is very high, which is manifested by low soil moisture to the point of not surviving seedlings at the first evaluation in spring.

- In scenarios of WA, the competition for the acquisition of nutrients has not been as strong, enabling higher survival in the woody species. It is strange that *Acacia acuminata* and *Eucalyptus accedens* preferred the scenario WA than NW to survive.

- Finally, the NW are the scenarios that have been behaving greater proliferation of seedlings with difference, mainly due to the non-competition for the acquisition of nutrients, as expressed with more moisture in the soil in reference to other scenarios.

Conclusions relating to the coexistence with native grass

- The coexistence of the different plant species with the native grass has not meant a relevant fact in regard to competition for the acquisition of nutrients, because the humidity values observed in pure and mixed scenarios are similar for all the three treatments done.

- In the long term, it is evidence of the beneficial effect of coexistence with native grass for *Eucalyptus loxophleba.* At the same time if the plant variety is resistant to drought episodes, it is beneficial the coexistence as such has been evident in the present experiment.

It is therefore considered that, through the different conclusions established, are answered the questions raison d'être of the project, being therefore reached the goal of the project, in response to the scope of the same.

CHAPTER 6. FUTURE WORK

In this section, a series of comments related to potential improvements in the field experiments will be presented, as well as possible issues that could have been made and contemplated but not performed:

- Perform more counts in the time to refine the best regression models, even so a methodology has been proposed (perish rate) that adapts to the behaviour of the seedlings.

- Introduce more resistant native species, in order to be able to demonstrate the effect even more beneficial in the long term of the native grass. Since *Eucalyptus loxophleba* is the only variety that resists the coexistence with weeds.

- Enter other varieties of Acacia, as all have had low emergency. In this way it may reveal more the role of the seed size.

- Perform control levels of nutrients in the ground to see the competition that can be set with the weeds, the mycorrhized roots of the eucalyptus and the ability to uptake of nitrogen in the acacias.

It's not been used the data of temperature, soil hardness and thickness of the surface layer of soil and biomass. There should be a study to see how also these variables affect the growth of seedlings.

CHAPTER 7. ACKNOWLEDGMENTS

The work presented in this Environmental Science Degree has been carried out at Plant Biology at the University of Western Australia (UWA) in Perth, Western Australia (Australia), and Facultat de Ciències of the Universitat Autònoma de Barcelona (UAB), Catalonia.

First, I would like to thank my supervisor, Juan Camilo Gabriello Pena, PhD Student of the UWA, for all his support, guidance and priceless lessons. I would also like to thank the director of the Ridgefield project to allow me to collaborate in the project in question, and for his help to make that possible. I would also like to thanks to the tutor of my project, Jordi Martínez Vilalta.

I'm especially grateful to the civil and structural engineer, Antonio Lara Silva, for his support, trust and encourage me in all the phases of the project, and for his lighting along the way.

Without being less important, I express gratitude to my parents for the economic support during my stay in Australia, and also for their support and confidence.

Especial gratitude to JOLP for start with me this adventure, trust and help me and at the end, being my countdown.

Calonge, September 2013

Paula Buenaventura Martínez

CHAPTER 8. REFERENCES

References relatives to botanical and ecological thematic

PROBER, S.M. and SMITH, F.P. (2009): Enhancing biodiversity persistence in intensively-used agricultural landscapes: a synthesis of 30 years of research in the Western Australian wheatbelt. Agriculture ecosystems & environment 132. 173-191.

MAESTRE, F. T. et al. (2012): “Positive interactions can produce species-rich communities and increase species turnover through time”, Journal of Plant Ecology No. 5: pp. 417-421.

SAILSBURY, E.J. (1942): The reproductive capacity of plants. George Bell & Sons, London.

SILVERTOWN, J.W. (1981): “Seed Size, Life Span, and Germination Date as Coadapted Features of Plant Life History”, The American Naturalist, Vol. 118, No. 6 (Dec., 1981), pp. 860-864.

JURADO, E. and WESTOBY, M. (1999): Crecimiento de plántulas en relación al tamaño de las semillas en la parte árida de Australia”, Facultad de Ciencias Forestales, Linares, N.L., México. Reporte Científico No. especial 19.

FENNER M. (1978): Seeds: The Ecology of Regeneration in Plant Communities. Library of Congress Cataliging-in-Publication Data. School of Biological Sciences, University of Southampton, UK.

SHIPLEY, B., and R.H. PETERS (1990): A test of the Tilman model of plant strategies: relative growth rate and biomass partitioning. *American Naturalist* 136: PP.139-153.

YATES, C.J. et al. (2000): Reserve concepts and conceptual reserves: options for the protection of fragmented ecosystems. Temperate Woodlands in Australia: Biology, Conservation, Management and Restoration. Surrey Beatty & Sons, Sydney, pp. 351-358.

BARROW N.J. et al. (1980); Describing the effect of time on sorption of phosphate by iron and aluminium hydroxides. Article first published online: 28 JUL 2006. Journal of Soil Science, Volume 36, Issue 2, pages 187–197.

SHARPLEY et al. (2004); Farming with grass. Outcomes of phosphorus-based nutrient management in the Eucha-Spavinaw Watershed. Professor, Department of Crop, Soil, and

Environmental Sciences,University of Arkansas, Fayetteville, Arkansas.

STANDISH R.J. et al. (2006): Legacy of land-use evident in soils of Western Australia's wheatbelt. Plant and Soil 280: 189–207.

SHANE M.W, LAMBERS H. and et al. (2006): Root structure and functioning for efficient acquisition of phosphorus: Matching morphological and physiological traits. Ann Bot. 2006 Oct;98(4):693-713. Epub 2006 Jun 12. Review.

STANDISH R.J. et al. (2008): Land-use legacy and the persistence of invasive Avena barbata on abandoned farmland. *Journal of Applied Ecology* 45: 1576–1583.

MARSHNER P. et al. (2005): Marschner's Mineral Nutrition of Higher Plants, Volum 89; Volum 95.

LAMBERS et al. (2010): Phosphorus Nutrition in Proteaceae. Plant Physiology Preview. Published on April 15, 2011, as DOI:10.1104/pp.111.174318.

STEVENS, J.M. and FEHMI, J.S. (2011): Early establishment of a native grass reduces the competitive effect of a non-native grass. Wiley-Blackwell, Boston, USA, Restoration Ecology, 2011, 19, 3, pp 399-406.

STEBBINS, G.L (1971): Annals of the Missouri Botanical Garden, Vol. 68, No. 1 (1981), pp. 75-86, Published by: Missouri Botanical Garden Press.

TOPP, G.C., DAVIS, J.L., and ANNAN, A.P. (1980): Electromagnetic determination of soil water content: measurement in coaxial transmission lines. Water Resources Research 16: 574-582.

GOMEZ, D.S, et al. (2006): Functional traits and plasticity linked to seedlings' performance under shade and drought in Mediterranean woody species. Ann. For. Sci. 65 (2007) 311 Available online at: www.afs-journal.org, DOI: 10.1051/forest:2008004

References relatives to the statistical analysis

CANOVOS, G.C. (1988): Probabilidad y estadística, aplicaciones y métodos. Virginia Commonwealth University.

Web references

- http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2435.2009.01612.x/full
- http://books.google.es/books?id=J_Dbxz_je20C&pg=PA192&lpg=PA192&dq=filoides+a+les+fulles+d%27acacia&source=bl&ots=dQdyuRcV4K&sig=6ri8iAa0nr9bU8ne-ppSIUVHBjw&hl=ca&sa=X&ei=68yoUbDIGNCQ7AaysoCICg&ved=0CDIQ6AEwAQ#v=onepage&q=filoides%20a%20les%20fulles%20d%27acacia&f=false
- http://www.bom.gov.au/climate/averages/tables/cw_009111.shtml
- http://www.perthtouristcentre.com.au/weather.php
- http://www.victoriannativeseed.com.au/?product=growing-australian-native-plants-from-seed
- http://plants.usda.gov/java/profile?symbol=EHLO3
- http://www.avaniplants.com/plant/ACACI/acacia
- http://australianseed.com/shop/category/australian-native-view-all-01
- http://www.flora.sa.gov.au
- http://anpsa.org.au/sgap1a.html
- http://www.florabank.org.au
- http://www.micofora.com
- http://cdigital.dgb.uanl.mx/la/1020129740/1020129740.PDF
- http://ecocrop.fao.org
- http://www.worldwidewattle.com/speciesgallery/browse.php?l=a
- http://malleenativeplants.com.au/acacia-pulchell-western-prickly-moses/
- http://www.friendsofqueensparkbushland.org.au/acacia-pulchella/
- http://www.nativegrassgroup.asn.au/index.html
- http://www.csu.edu.au/herbarium/species-list
- http://www.agric.wa.gov.au/PC_93283.html
- http://en.wikipedia.org/wiki/Avon_River_(Western_Australia)
- http://www.viarural.com.ar/viarural.com.ar/insumosagropecuarios/agricolas/agronomias/sumidea/termometro-para-suelo-acero-inoxidable.htm
- http://soilweb.landfood.ubc.ca/labmodules/water/time-domain-reflectometry
- http://www.daff.gov.au/climatechange
- http://www.daff.gov.au/climatechange/australias-farming-future/climate-change-and-productivity-research/livestock-methane-research

APPENDIX

Shapiro-Wilk tests

The following sections list the various tests of normality concerning all samples were obtained for each project stage and for each plant variety.

Acacia acuminata

Tests of Normality[c,d,e,f,g,h,i,j,k,l]

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
NWP1_1	,478	10	,000	,539	10	,000
NWM1_1	,382	10	,000	,559	10	,000
NWM1_1P	,353	10	,001	,621	10	,000
WAP1_1	,172	10	,200*	,883	10	,140
WAM1_1	,412	10	,000	,647	10	,000
WAM1_1P	,304	10	,009	,748	10	,003
WEP1_1	,289	10	,018	,796	10	,013
WEM1_1	,367	10	,000	,680	10	,000
NWP1_2	,472	10	,000	,532	10	,000
NWM1_2	,333	10	,002	,678	10	,000
NWM1_2P	,351	10	,001	,596	10	,000
WAP1_2	,220	10	,185	,865	10	,087
WAM1_2P	,402	10	,000	,605	10	,000
WEP1_2	,524	10	,000	,366	10	,000
NWP1_3	,466	10	,000	,516	10	,000
NWM1_3	,482	10	,000	,509	10	,000
NWM1_3P	,394	10	,000	,515	10	,000
WAP1_3	,359	10	,001	,740	10	,003
WAM1_3	,524	10	,000	,366	10	,000

WAM1_3P	,482	10	,000	,509	10	**,000**
NWP1_4	,472	10	,000	,532	10	**,000**
NWM1_4	,482	10	,000	,509	10	**,000**
NWM1_4P	,394	10	,000	,515	10	**,000**
WAP1_4	,427	10	,000	,652	10	**,000**
WAM1_4	,524	10	,000	,366	10	**,000**
WAM1_4P	,482	10	,000	,509	10	**,000**

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

c. WEM1_1P is constant. It has been omitted.

d. WAM1_2 is constant. It has been omitted.

e. WEM1_2 is constant. It has been omitted.

f. WEM1_2P is constant. It has been omitted.

g. WEP1_3 is constant. It has been omitted.

h. WEM1_3 is constant. It has been omitted.

i. WEM1_3P is constant. It has been omitted.

j. WEP1_4 is constant. It has been omitted.

k. WEM1_4 is constant. It has been omitted.

l. WEM1_4P is constant. It has been omitted.

Acacia pulchella

Tests of Normality[b,c,d,e,f,g,h,i,j,k,l,m]

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
NWP2_1	,399	10	,000	,616	10	**,000**
NWM2_1	,250	10	,078	,823	10	**,028**
NWM2_1P	,330	10	,003	,575	10	**,000**
WAP2_1	,248	10	,082	,855	10	**,067**

WAM2_1	,397	10	,000	,603	10	**,000**
WAM2_1P	,264	10	,046	,782	10	**,009**
WEP2_1	,372	10	,000	,527	10	**,000**
WEM2_1	,362	10	,001	,717	10	**,001**
NWP2_2	,372	10	,000	,527	10	**,000**
NWM2_2	,233	10	,131	,824	10	**,028**
NWM2_2P	,309	10	,008	,630	10	**,000**
WAP2_2	,322	10	,004	,676	10	**,000**
WAM2_2	,482	10	,000	,509	10	**,000**
WAM2_2P	,457	10	,000	,487	10	**,000**
NWP2_3	,448	10	,000	,456	10	**,000**
NWM2_3	,461	10	,000	,500	10	**,000**
NWM2_3P	,386	10	,000	,583	10	**,000**
WAP2_3	,312	10	,007	,622	10	**,000**
WAM2_3P	,524	10	,000	,366	10	**,000**
NWP2_4	,448	10	,000	,456	10	**,000**
NWM2_4	,461	10	,000	,500	10	**,000**
NWM2_4P	,386	10	,000	,583	10	**,000**
WAP2_4	,312	10	,007	,622	10	**,000**
WAM2_4P	,524	10	,000	,366	10	**,000**

a. Lilliefors Significance Correction

b. WEM2_1P is constant. It has been omitted.

c. WEP2_2 is constant. It has been omitted.

d. WEM2_2 is constant. It has been omitted.

e. WEM2_2P is constant. It has been omitted.

f. WAM2_3 is constant. It has been omitted.

g. WEP2_3 is constant. It has been omitted.

h. WEM2_3 is constant. It has been omitted.

i. WEM2_3P is constant. It has been omitted.

j. WAM2_4 is constant. It has been omitted.

k. WEP2_4 is constant. It has been omitted.

l. WEM2_4 is constant. It has been omitted.

m. WEM2_4P is constant. It has been omitted.

Acacia sessilis

Tests of Normality[a,b,e,f,g,h,i,j,k,l,m,n,o,p,q,r,s,t,u,v,w,x,y,z,aa,ab,ac,ad]

	Kolmogorov-Smirnov[c]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
NWM3_1P	,175	10	,200*	,861	10	,078
WAM3_1P	,254	10	,066	,839	10	,043
NWM3_2P	,226	10	,161	,845	10	,050
WAM3_2P	,245	10	,091	,776	10	,007
NWM3_3P	,326	10	,003	,671	10	,000
WAM3_3P	,416	10	,000	,650	10	,000
NWM3_4P	,328	10	,003	,694	10	,001
WAM3_4P	,412	10	,000	,647	10	,000

*. This is a lower bound of the true significance.

a. NWP3_1 is constant. It has been omitted.

b. NWM3_1 is constant. It has been omitted.

c. Lilliefors Significance Correction

e. WAP3_1 is constant. It has been omitted.

f. WAM3_1 is constant. It has been omitted.

g. WEP3_1 is constant. It has been omitted.

h. WEM3_1 is constant. It has been omitted.

i. WEM3_1P is constant. It has been omitted.

j. NWP3_2 is constant. It has been omitted.

k. NWM3_2 is constant. It has been omitted.

l. WAP3_2 is constant. It has been omitted.

m. WAM3_2 is constant. It has been omitted.

n. WEP3_2 is constant. It has been omitted.

o. WEM3_2 is constant. It has been omitted.

p. WEM3_2P is constant. It has been omitted.

q. NWP3_3 is constant. It has been omitted.

r. NWM3_3 is constant. It has been omitted.

s. WAP3_3 is constant. It has been omitted.

t. WAM3_3 is constant. It has been omitted.

u. WEP3_3 is constant. It has been omitted.

v. WEM3_3 is constant. It has been omitted.

w. WEM3_3P is constant. It has been omitted.

x. NWP3_4 is constant. It has been omitted.

y. NWM3_4 is constant. It has been omitted.

z. WAP3_4 is constant. It has been omitted.

aa. WAM3_4 is constant. It has been omitted.

ab. WEP3_4 is constant. It has been omitted.

ac. WEM3_4 is constant. It has been omitted.

ad. WEM3_4P is constant. It has been omitted.

Eucalyptus accendens

Tests of Normality[c,d,e,f,g,h,i,j,k,l,m,n]

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
NWP4_1	,164	10	,200*	,922	10	,373
NWM4_1	,229	10	,148	,859	10	,074
NWM4_1P	,159	10	,200*	,900	10	,220

WAP4_1	,345	10	,001	,646	10	**,000**
WAM4_1	,289	10	,018	,855	10	**,067**
WAM4_1P	,236	10	,120	,945	10	**,611**
WEP4_1	,433	10	,000	,594	10	**,000**
WEM4_1	,400	10	,000	,623	10	**,000**
NWP4_2	,192	10	,200*	,905	10	**,246**
NWM4_2	,342	10	,002	,682	10	**,001**
NWM4_2P	,272	10	,034	,701	10	**,001**
WAP4_2	,262	10	,051	,773	10	**,007**
WAM4_2	,524	10	,000	,366	10	**,000**
WAM4_2P	,398	10	,000	,687	10	**,001**
NWP4_3	,333	10	,002	,693	10	**,001**
NWM4_3	,524	10	,000	,366	10	**,000**
NWM4_3P	,283	10	,023	,801	10	**,015**
WAP4_3	,346	10	,001	,730	10	**,002**
WAM4_3P	,453	10	,000	,475	10	**,000**
NWP4_4	,406	10	,000	,624	10	**,000**
NWM4_4	,524	10	,000	,366	10	**,000**
NWM4_4P	,283	10	,023	,801	10	**,015**
WAP4_4	,346	10	,001	,730	10	**,002**
WAM4_4P	,453	10	,000	,475	10	**,000**

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

c. WEM4_1P is constant. It has been omitted.

d. WEP4_2 is constant. It has been omitted.

e. WEM4_2 is constant. It has been omitted.

f. WEM4_2P is constant. It has been omitted.

g. WAM4_3 is constant. It has been omitted.

h. WEP4_3 is constant. It has been omitted.

i. WEM4_3 is constant. It has been omitted.

j. WEM4_3P is constant. It has been omitted.

k. WAM4_4 is constant. It has been omitted.

l. WEP4_4 is constant. It has been omitted.

m. WEM4_4 is constant. It has been omitted.

n. WEM4_4P is constant. It has been omitted.

Eucalyptus astringens

Tests of Normality[c,d,e,f,g,h,i,j,k,l,m,n]

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
NWP5_1	,235	10	,124	,797	10	**,013**
NWM5_1	,157	10	,200*	,893	10	**,185**
NWM5_1P	,202	10	,200*	,926	10	**,411**
WAP5_1	,184	10	,200*	,885	10	**,150**
WAM5_1	,201	10	,200*	,860	10	**,076**
WAM5_1P	,206	10	,200*	,841	10	**,046**
WEP5_1	,252	10	,073	,713	10	**,001**
WEM5_1	,366	10	,000	,687	10	**,001**
NWP5_2	,316	10	,006	,774	10	**,007**
NWM5_2	,281	10	,024	,644	10	**,000**
NWM5_2P	,215	10	,200*	,864	10	**,084**
WAP5_2	,229	10	,147	,780	10	**,008**
WAM5_2	,397	10	,000	,580	10	**,000**
WAM5_2P	,358	10	,001	,713	10	**,001**
NWP5_3	,364	10	,000	,607	10	**,000**
NWM5_3	,330	10	,003	,539	10	**,000**

NWM5_3P	,308	10	,008	,800	10	,015
WAP5_3	,422	10	,000	,628	10	,000
WAM5_3	,457	10	,000	,487	10	,000
NWP5_4	,364	10	,000	,607	10	,000
NWM5_4	,330	10	,003	,539	10	,000
NWM5_4P	,308	10	,008	,800	10	,015
WAP5_4	,422	10	,000	,628	10	,000
WAM5_4	,453	10	,000	,475	10	,000

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

c. WEM5_1P is constant. It has been omitted.

d. WEP5_2 is constant. It has been omitted.

e. WEM5_2 is constant. It has been omitted.

f. WE5_2P is constant. It has been omitted.

g. WAM5_3P is constant. It has been omitted.

h. WEP5_3 is constant. It has been omitted.

i. WEM5_3 is constant. It has been omitted.

j. WEM5_3P is constant. It has been omitted.

k. WAM5_4P is constant. It has been omitted.

l. WEP5_4 is constant. It has been omitted.

m. WEM5_4 is constant. It has been omitted.

n. WEM5_4P is constant. It has been omitted.

Eucalyptus loxophleba

Tests of Normality[c,d,e,f,g,h,i,j,k,l]

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
NWP6_1	,209	10	,200*	,917	10	,331

NWM6_1	,238	10	,113	,796	10	,013
NWM6_1P	,288	10	,019	,874	10	,113
WAP6_1	,189	10	,200*	,892	10	,179
WAM6_1	,308	10	,008	,762	10	,005
WAM6_1P	,414	10	,000	,612	10	,000
WEP6_1	,356	10	,001	,609	10	,000
WEM6_1	,266	10	,043	,700	10	,001
NWP6_2	,313	10	,006	,777	10	,008
NWM6_2	,293	10	,015	,729	10	,002
NWM6_2P	,179	10	,200*	,871	10	,103
WAP6_2	,365	10	,000	,744	10	,003
WAM6_2	,394	10	,000	,477	10	,000
WAM6_2P	,408	10	,000	,477	10	,000
NWP6_3	,405	10	,000	,523	10	,000
NWM6_3	,336	10	,002	,746	10	,003
NWM6_3P	,279	10	,026	,675	10	,000
WAP6_3	,333	10	,002	,708	10	,001
WAM6_3	,524	10	,000	,366	10	,000
WAM6_3P	,382	10	,000	,559	10	,000
NWP6_4	,410	10	,000	,489	10	,000
NWM6_4	,382	10	,000	,677	10	,000
NWM6_4P	,279	10	,026	,675	10	,000
WAP6_4	,339	10	,002	,675	10	,000
WAM6_4	,524	10	,000	,366	10	,000
WAM6_4P	,382	10	,000	,559	10	,000

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

c. WEM6_1P is constant. It has been omitted.

d. WEP6_2 is constant. It has been omitted.

e. WEM6_2 is constant. It has been omitted.

f. WEM6_2P is constant. It has been omitted.

g. WEP6_3 is constant. It has been omitted.

h. WEM6_3 is constant. It has been omitted.

i. WEM6_3P is constant. It has been omitted.

j. WEP6_4 is constant. It has been omitted.

k. WEM6_4 is constant. It has been omitted.

l. WEM6_4P is constant. It has been omitted.

Austrodanthonia caespitosa

Tests of Normality[c,d,e]

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
NWP7_1	,169	10	,200*	,914	10	**,307**
WAP7_1	,266	10	,043	,792	10	**,012**
WEP7_1	,355	10	,001	,715	10	**,001**
NWP7_2	,205	10	,200*	,890	10	**,170**
WAP7_2	,268	10	,040	,743	10	**,003**
NWP7_3	,205	10	,200*	,809	10	**,019**
WAP7_3	,406	10	,000	,588	10	**,000**
NWP7_4	,243	10	,095	,803	10	**,016**
WAP7_4	,406	10	,000	,588	10	**,000**

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

c. WEP7_2 is constant. It has been omitted.

d. WEP7_3 is constant. It has been omitted.

e. WEP7_4 is constant. It has been omitted.

Central tendency estimators tables

Attached below is a series of tables relating to the calculation of the estimators of central tendency for each plant variety. It is intended to denote the differences between the choice of an estimator or other, as well as reflect the estimators finally employees for each stage of project, making a ranking between the type of treatment used.

Acacia acuminata. No Weed

Statistics

		NWP1_1	NWM1_1	NWM1_1P	NWP1_2	NWM1_2	NWM1_2P	NWP1_3	NWM1_3	NWM1_3P	NWP1_4	NWM1_4	NWM1_4P
N	Valid	10	10	10	10	10	10	10	10	10	10	10	10
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean		**,5000**	**,6000**	**2,5000**	**,6000**	**,6000**	**3,3000**	**,7000**	**,2000**	**2,1000**	**,6000**	**,2000**	**2,1000**
Median		**,0000**	**,0000**	**1,0000**	**,0000**	**,0000**	**1,5000**	**,0000**	**,0000**	**,5000**	**,0000**	**,0000**	**,5000**
Std. Deviation		1,08012	1,26491	4,27525	1,34990	,96609	5,71645	1,63639	,42164	4,62961	1,34990	,42164	4,62961
Percentiles	25	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000
	75	,5000	1,0000	3,0000	,5000	1,0000	4,0000	,5000	,2500	1,5000	,5000	,2500	1,5000

Acacia acuminata. Weed After

Statistics

		WAP1_1	WAM1_1	WAM1_1P	WAP1_2	WAM1_2	WAM1_2P	WAP1_3	WAM1_3	WAM1_3P	WAP1_4	WAM1_4	WAM1_4P
N	Valid	10	10	10	10	10	10	10	10	10	10	10	10
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean		**1,7000**	**,6000**	**1,6000**	**1,3000**	**,0000**	**1,0000**	**,8000**	**,1000**	**,2000**	**,7000**	**,1000**	**,2000**
Median		**1,5000**	**,0000**	**,5000**	**1,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**
Std. Deviation		1,56702	1,07497	2,27058	1,41814	,00000	1,88562	1,13529	,31623	,42164	1,15950	,31623	,42164
Percentiles	25	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000

	75	3,2500	1,2500	3,5000	2,2500	,0000	1,7500	2,0000	,0000	,2500	2,0000	,0000	,2500

Acacia acuminata. Weed

Statistics

		WEP1_1	WEM1_1	WEM1_1P	WEP1_2	WEM1_2	WEM1_2P	WEP1_3	WEM1_3	WEM1_3P	WEP1_4	WEM1_4	WEM1_4P
N	Valid	10	10	10	10	10	10	10	10	10	10	10	10
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean		**1,1000**	**,9000**	**,0000**	**,1000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**
Median		**,5000**	**1,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**
Std. Deviation		1,37032	1,19722	,00000	,31623	,00000	,00000	,00000	,00000	,00000	,00000	,00000	,00000
Percentiles	25	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000
	75	2,0000	1,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000

Acacia pulchella. No Weed

Statistics

		NWP2_1	NWM2_1	NWM2_1P	NWP2_2	NWM2_2	NWM2_2P	NWP2_3	NWM2_3	NWM2_3P	NWP2_4	NWM2_4	NWM2_4P
N	Valid	10	10	10	10	10	10	10	10	10	10	10	10
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean		**,9000**	**2,3000**	**7,6000**	**,7000**	**1,1000**	**3,6000**	**,6000**	**,4000**	**2,5000**	**,6000**	**,4000**	**2,5000**
Median		**,0000**	**2,0000**	**2,5000**	**,0000**	**1,0000**	**2,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**
Std. Deviation		1,72884	2,40601	13,58267	1,56702	1,19722	6,05897	1,57762	,96609	5,14782	1,57762	,96609	5,14782
Percentiles	25	,0000	,0000	1,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000
	75	1,5000	3,2500	9,2500	1,0000	2,2500	4,2500	,2500	,2500	3,7500	,2500	,2500	3,7500

Acacia pulchella. Weed After

Statistics

		WAP2_1	WAM2_1	WAM2_1P	WAP2_2	WAM2_2	WAM2_2P	WAP2_3	WAM2_3	WAM2_3P	WAP2_4	WAM2_4	WAM2_4P
N	Valid	10	10	10	10	10	10	10	10	10	10	10	10
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean		**1,6000**	**,5000**	**1,7000**	**1,0000**	**,2000**	**,9000**	**,7000**	**,0000**	**,5000**	**,7000**	**,0000**	**,5000**
Median		**1,0000**	**,0000**	**,5000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**
Std. Deviation		1,57762	,97183	2,35938	1,69967	,42164	2,23358	1,25167	,00000	1,58114	1,25167	,00000	1,58114
Percentiles	25	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000
	75	3,2500	1,0000	3,2500	1,5000	,2500	,5000	1,0000	,0000	,0000	1,0000	,0000	,0000

Acacia pulchella. Weed

Statistics

		WEP2_1	WEM2_1	WEM2_1P	WEP2_2	WEM2_2	WEM2_2P	WEP2_3	WEM2_3	WEM2_3P	WEP2_4	WEM2_4	WEM2_4P
N	Valid	10	10	10	10	10	10	10	10	10	10	10	10
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean		**,7000**	**,6000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**
Median		**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**
Std. Deviation		1,56702	,84327	,00000	,00000	,00000	,00000	,00000	,00000	,00000	,00000	,00000	,00000
Percentiles	25	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000
	75	1,0000	1,2500	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000

Acacia sessilis. No Weed

Statistics

		NWP3_1	NWM3_1	NWM3_1P	NWP3_2	NWM3_2	NWM3_2P	NWP3_3	NWM3_3	NWM3_3P	NWP3_4	NWM3_4	NWM3_4P
N	Valid	10	10	10	10	10	10	10	10	10	10	10	10

	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean		**,0000**	**,0000**	**3,7000**	**,0000**	**,0000**	**3,5000**	**,0000**	**,0000**	**2,1000**	**,0000**	**,0000**	**,8000**
Median		**,0000**	**,0000**	**3,5000**	**,0000**	**,0000**	**2,0000**	**,0000**	**,0000**	**1,0000**	**,0000**	**,0000**	**,0000**
Std. Deviation		,00000	,00000	3,74314	,00000	,00000	4,17000	,00000	,00000	3,41402	,00000	,00000	1,31656
Percentiles	25	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000
	75	,0000	,0000	5,2500	,0000	,0000	6,5000	,0000	,0000	3,2500	,0000	,0000	1,2500

Acacia sessilis. Weed After

Statistics

		WAP3_1	WAM3_1	WAM3_1P	WAP3_2	WAM3_2	WAM3_2P	WAP3_3	WAM3_3	WAM3_3P	WAP3_4	WAM3_4	WAM3_4P
N	Valid	10	10	10	10	10	10	10	10	10	10	10	10
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean		**,0000**	**,0000**	**3,5000**	**,0000**	**,0000**	**1,7000**	**,0000**	**,0000**	**,8000**	**,0000**	**,0000**	**,6000**
Median		**,0000**	**,0000**	**2,0000**	**,0000**	**,0000**	**1,5000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**
Std. Deviation		,00000	,00000	3,77859	,00000	,00000	2,16282	,00000	,00000	1,39841	,00000	,00000	1,07497
Percentiles	25	,0000	,0000	,7500	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000
	75	,0000	,0000	6,2500	,0000	,0000	2,2500	,0000	,0000	2,0000	,0000	,0000	1,2500

Acacia sessilis. Weed

Statistics

		WEP3_1	WEM3_1	WEM3_1P	WEP3_2	WEM3_2	WEM3_2P	WEP3_3	WEM3_3	WEM3_3P	WEP3_4	WEM3_4	WEM3_4P
N	Valid	10	10	10	10	10	10	10	10	10	10	10	10
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean		**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**
Median		**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**
Std. Deviation		,00000	,00000	,00000	,00000	,00000	,00000	,00000	,00000	,00000	,00000	,00000	,00000

Percentiles	25	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000
	75	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000

Eucalyptus accendens. No Weed

Statistics

		NWP4_1	NWM4_1	NWM4_1P	NWP4_2	NWM4_2	NWM4_2P	NWP4_3	NWM4_3	NWM4_3P	NWP4_4	NWM4_4	NWM4_4P
N	Valid	10	10	10	10	10	10	10	10	10	10	10	10
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean		**2,9000**	**1,0000**	**3,4000**	**1,9000**	**,8000**	**4,2000**	**,9000**	**,2000**	**2,1000**	**,8000**	**,2000**	**2,1000**
Median		**2,5000**	**1,0000**	**3,0000**	**1,5000**	**,0000**	**2,0000**	**,0000**	**,0000**	**1,0000**	**,0000**	**,0000**	**1,0000**
Std. Deviation		2,64365	1,05409	3,40588	1,79196	1,22927	6,57943	1,44914	,63246	2,68535	1,47573	,63246	2,68535
Percentiles	25	,7500	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000
	75	4,5000	2,0000	6,2500	3,2500	1,5000	6,0000	1,5000	,0000	4,0000	1,5000	,0000	4,0000

Eucalyptus accendens. Weed After

Statistics

		WAP4_1	WAM4_1	WAM4_1P	WAP4_2	WAM4_2	WAM4_2P	WAP4_3	WAM4_3	WAM4_3P	WAP4_4	WAM4_4	WAM4_4P
N	Valid	10	10	10	10	10	10	10	10	10	10	10	10
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean		**2,5000**	**1,3000**	**4,0000**	**1,2000**	**,1000**	**1,6000**	**,7000**	**,0000**	**,5000**	**,7000**	**,0000**	**,5000**
Median		**,5000**	**1,0000**	**3,0000**	**,5000**	**,0000**	**1,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**
Std. Deviation		4,42844	1,33749	2,86744	1,68655	,31623	2,41293	1,05935	,00000	1,26930	1,05935	,00000	1,26930
Percentiles	25	,0000	,0000	1,7500	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000
	75	3,5000	2,2500	6,2500	2,2500	,0000	2,0000	1,2500	,0000	,2500	1,2500	,0000	,2500

Eucalyptus accendens. Weed

Statistics

		WEP4_1	WEM4_1	WEM4_1P	WEP4_2	WEM4_2	WEM4_2P	WEP4_3	WEM4_3	WEM4_3P	WEP4_4	WEM4_4	WEM4_4P
N	Valid	10	10	10	10	10	10	10	10	10	10	10	10
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean		**,3000**	**,7000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**
Median		**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**
Std. Deviation		,48305	1,33749	,00000	,00000	,00000	,00000	,00000	,00000	,00000	,00000	,00000	,00000
Percentiles	25	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000
	75	1,0000	1,2500	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000

Eucalyptus astringens. No Weed

Statistics

		NWP5_1	NWM5_1	NWM5_1P	NWP5_2	NWM5_2	NWM5_2P	NWP5_3	NWM5_3	NWM5_3P	NWP5_4	NWM5_4	NWM5_4P
N	Valid	10	10	10	10	10	10	10	10	10	10	10	10
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean		**15,1000**	**9,3000**	**5,0000**	**11,2000**	**5,2000**	**2,5000**	**5,9000**	**3,7000**	**3,4000**	**5,9000**	**3,7000**	**3,4000**
Median		**14,5000**	**7,0000**	**4,0000**	**5,5000**	**1,0000**	**1,5000**	**,0000**	**,0000**	**1,0000**	**,0000**	**,0000**	**1,0000**
Std. Deviation		16,22378	9,09273	3,85861	14,29685	8,96660	2,63523	11,58975	8,11104	4,37671	11,58975	8,11104	4,37671
Percentiles	25	1,7500	1,7500	1,0000	1,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000
	75	19,7500	14,7500	8,5000	20,2500	7,2500	5,2500	9,5000	4,5000	6,7500	9,5000	4,5000	6,7500

Eucalyptus astringens. Weed After

Statistics

		WAP5_1	WAM5_1	WAM5_1P	WAP5_2	WAM5_2	WAM5_2P	WAP5_3	WAM5_3	WAM5_3P	WAP5_4	WAM5_4	WAM5_4P
N	Valid	10	10	10	10	10	10	10	10	10	10	10	10
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean		**10,6000**	**5,7000**	**2,3000**	**3,8000**	**1,4000**	**,9000**	**,5000**	**,9000**	**,0000**	**,5000**	**1,0000**	**,0000**
Median		**8,0000**	**4,5000**	**1,5000**	**2,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**
Std. Deviation		9,78888	5,18652	2,40601	5,11642	2,71621	1,28668	,84984	2,23358	,00000	,84984	2,53859	,00000
Percentiles	25	3,0000	2,5000	,7500	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000
	75	17,2500	7,5000	3,2500	7,0000	2,2500	2,2500	1,2500	,5000	,0000	1,2500	,5000	,0000

Eucalyptus astringens. Weed

Statistics

		WEP5_1	WEM5_1	WEM5_1P	WEP5_2	WEM5_2	WE5_2P	WEP5_3	WEM5_3	WEM5_3P	WEP5_4	WEM5_4	WEM5_4P
N	Valid	10	10	10	10	10	10	10	10	10	10	10	10
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean		**3,1000**	**1,8000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**
Median		**1,5000**	**1,5000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**
Std. Deviation		4,62961	2,34758	,00000	,00000	,00000	,00000	,00000	,00000	,00000	,00000	,00000	,00000
Percentiles	25	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000
	75	5,0000	2,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000

Eucalyptus loxophleba. No Weed

Statistics

		NWP6_1	NWM6_1	NWM6_1P	NWP6_2	NWM6_2	NWM6_2P	NWP6_3	NWM6_3	NWM6_3P	NWP6_4	NWM6_4	NWM6_4P
N	Valid	10	10	10	10	10	10	10	10	10	10	10	10
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean		**10,2000**	**8,5000**	**7,8000**	**5,2000**	**5,3000**	**5,7000**	**2,4000**	**5,3000**	**3,0000**	**2,9000**	**4,1000**	**3,0000**
Median		**8,5000**	**4,0000**	**6,5000**	**4,0000**	**1,0000**	**4,5000**	**,5000**	**,5000**	**,5000**	**,5000**	**,0000**	**,5000**
Std. Deviation		8,81665	9,89107	6,54557	6,25033	6,53282	5,79367	5,27468	6,81583	5,12076	6,82235	6,55659	5,12076
Percentiles	25	3,5000	1,0000	4,0000	,7500	,0000	1,5000	,0000	,0000	,0000	,0000	,0000	,0000
	75	16,5000	15,2500	10,2500	6,7500	13,2500	9,2500	1,7500	12,0000	4,7500	1,7500	11,2500	4,7500

Eucalyptus loxophleba. Weed After

Statistics

		WAP6_1	WAM6_1	WAM6_1P	WAP6_2	WAM6_2	WAM6_2P	WAP6_3	WAM6_3	WAM6_3P	WAP6_4	WAM6_4	WAM6_4P
N	Valid	10	10	10	10	10	10	10	10	10	10	10	10
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean		**14,7000**	**9,1000**	**2,1000**	**4,3000**	**2,5000**	**2,1000**	**1,5000**	**1,6000**	**,6000**	**1,9000**	**1,6000**	**,6000**
Median		**13,5000**	**3,5000**	**1,5000**	**,0000**	**,0000**	**,5000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**
Std. Deviation		10,88373	11,33774	2,88483	5,96378	6,27606	4,93176	2,41523	5,05964	1,26491	2,96086	5,05964	1,26491
Percentiles	25	4,7500	,7500	,7500	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000
	75	24,2500	19,7500	2,0000	10,5000	1,7500	1,2500	3,2500	,0000	1,0000	4,7500	,0000	1,0000

Eucalyptus loxophleba. Weed

Statistics

		WEP6_1	WEM6_1	WEM6_1P	WEP6_2	WEM6_2	WEM6_2P	WEP6_3	WEM6_3	WEM6_3P	WEP6_4	WEM6_4	WEM6_4P
N	Valid	10	10	10	10	10	10	10	10	10	10	10	10
	Missing	0	0	0	0	0	0	0	0	0	0	0	0
Mean		**2,7000**	**2,6000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**
Median		**,0000**	**,5000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**	**,0000**
Std. Deviation		4,96767	4,16867	,00000	,00000	,00000	,00000	,00000	,00000	,00000	,00000	,00000	,00000
Percentiles	25	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000
	75	4,2500	5,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000	,0000

Austrodanthonia caespitosa. No Weed

Statistics

		NWP7_1	NWP7_2	NWP7_3	NWP7_4
N	Valid	10	10	10	10
	Missing	0	0	0	0
Mean		**13,9000**	**10,6000**	**4,7000**	**4,7000**
Median		**13,5000**	**9,5000**	**3,0000**	**2,5000**
Std. Deviation		8,92500	8,54010	5,41705	5,65784
Percentiles	25	5,0000	3,2500	,0000	,0000
	75	19,7500	19,5000	8,0000	9,5000

Austrodanthonia caespitosa. Weed After

Statistics

		WAP7_1	WAP7_2	WAP7_3	WAP7_4
N	Valid	10	10	10	10
	Missing	0	0	0	0
Mean		**7,5000**	**4,0000**	**,9000**	**,9000**

Median		**5,0000**	**1,5000**	**,0000**	**,0000**
Std. Deviation		8,98455	5,83095	1,66333	1,66333
Percentiles	25	1,0000	,0000	,0000	,0000
	75	11,5000	8,0000	1,7500	1,7500

Austrodanthonia caespitosa. Weed

Statistics

		WEP7_1	WEP7_2	WEP7_3	WEP7_4
N	Valid	10	10	10	10
	Missing	0	0	0	0
Mean		**1,1000**	**,0000**	**,0000**	**,0000**
Median		**,0000**	**,0000**	**,0000**	**,0000**
Std. Deviation		1,59513	,00000	,00000	,00000
Percentiles	25	,0000	,0000	,0000	,0000
	75	3,0000	,0000	,0000	,0000

Regression analysis tables

REGRESSION ANALYSIS FOR *A. acuminata*		
Treatment	**Slope of the linear regression model**	**Adjusted R^2**
No Weed Pure plot	0	1
No Weed Mixed plot	0	1
Weed After Pure plot	-0.064	0.816
Weed After Mixed plot	0	1
Weed Pure plot	-0.02	0.652
Weed Mixed plot	-0.04	0.652

Table 5. Regression analysis for *A. acuminata*

REGRESSION ANALYSIS FOR *A. pulchella*		
Treatment	**Slope of the linear regression model**	**Adjusted R^2**
No Weed Pure plot	0	1
No Weed Mixed plot	-0.084	0.890
Weed After Pure plot	-0.04	0.652
Weed After Mixed plot	0	1
Weed Pure plot	0	1
Weed Mixed plot	0	1

Table 6. Regression analysis for *A. pulchella*

REGRESSION ANALYSIS FOR *E. accedens*		
Treatment	**Slope of the linear regression model**	**Adjusted R^2**
No Weed Pure plot	-0.105	0.854
No Weed Mixed plot	-0.04	0.652
Weed After Pure plot	-0.022	0.552
Weed After Mixed plot	-0.04	0.652
Weed Pure plot	0	1
Weed Mixed plot	0	1

Table 7. Regression analysis for *E. accedens*

REGRESSION ANALYSIS FOR *E. astringens*		
Treatment	**Slope of the linear regression model**	**Adjusted R^2**
No Weed Pure plot	-0.599	0.896
No Weed Mixed plot	-0.284	0.833
Weed After Pure plot	-0.326	0.853
Weed After Mixed plot	-0.179	0.652
Weed Pure plot	-0.06	0.652
Weed Mixed plot	-0.06	0.652

Table 8. Regression analysis for *E. astringens*

REGRESSION ANALYSIS FOR *E. loxophleba*		
Treatment	**Slope of the linear regression model**	**Adjusted R^2**

No Weed Pure plot	-0.332	0.899
No Weed Mixed plot	-0.157	0.890
Weed After Pure plot	-0.536	0.652
Weed After Mixed plot	-0.141	0.782
Weed Pure plot	0	1
Weed Mixed plot	-0.02	0.652

Table 9. Regression analysis for *E. loxophleba*

REGRESSION ANALYSIS FOR *A. caespitosa*		
Treatment	**Slope of the linear regression model**	**Adjusted R^2**
No Weed Pure plot	-0.46	0.866
Weed After Pure plot	-0.205	0.876
Weed Pure plot	0	1

Table 10. Regression analysis for *A. caespitosa*

Soil moist graphs

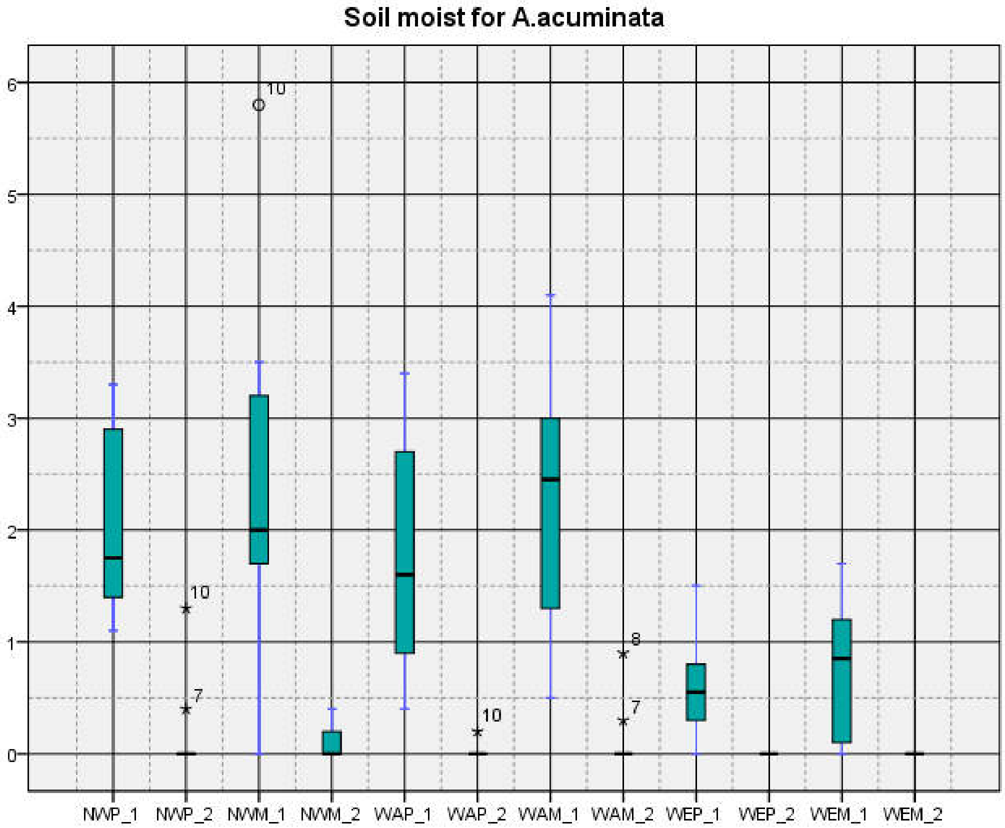


Figure 68. Soil moist for *A. acuminata*

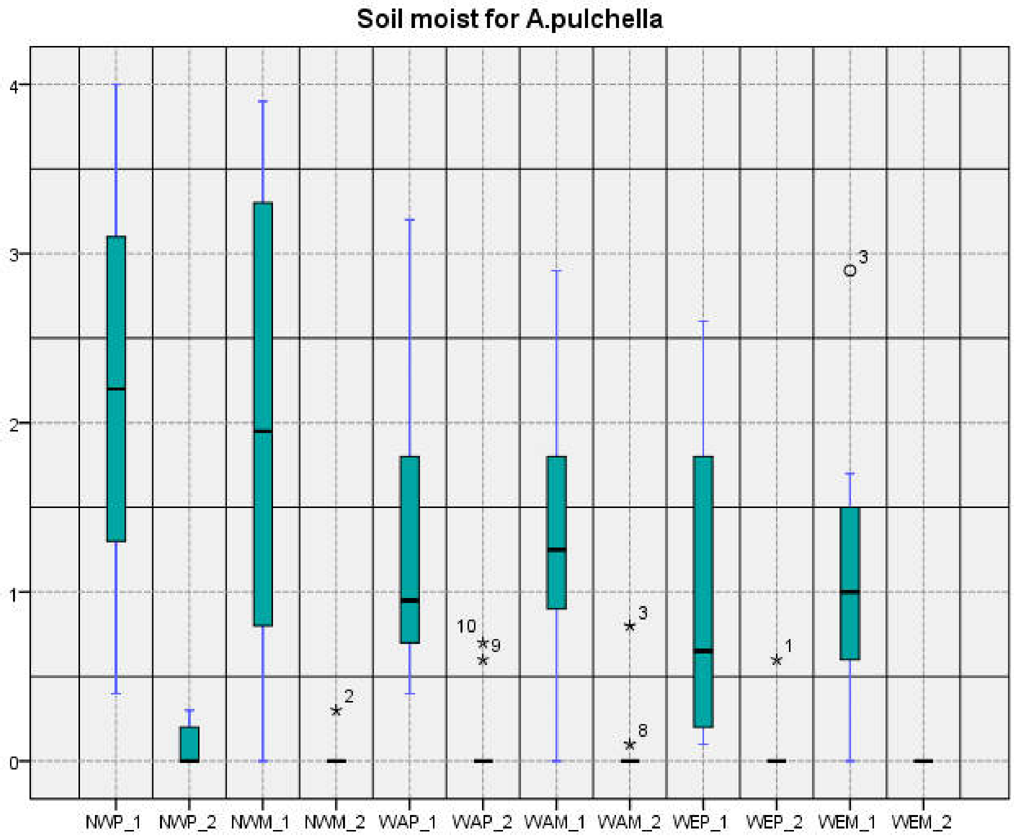


Figure 69. Soil moist for *A. pulchella*

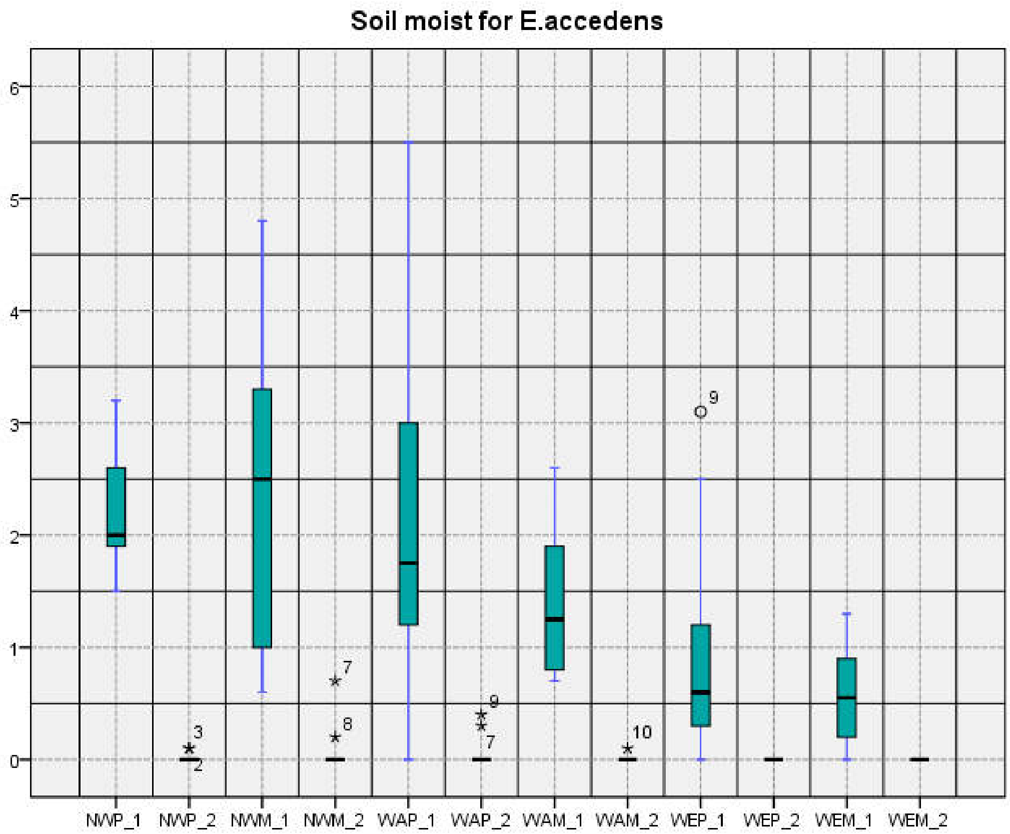


Figure 70. Soil moist for *E. accedens*

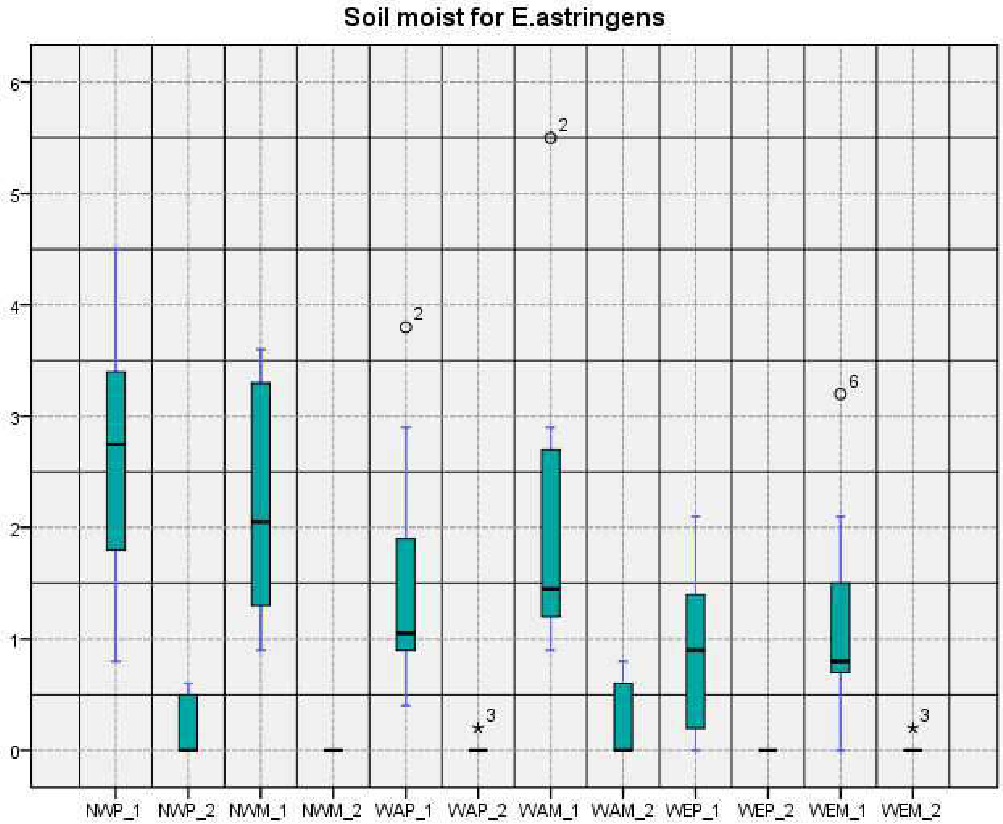


Figure 71. Soil moist for *E. astringens*

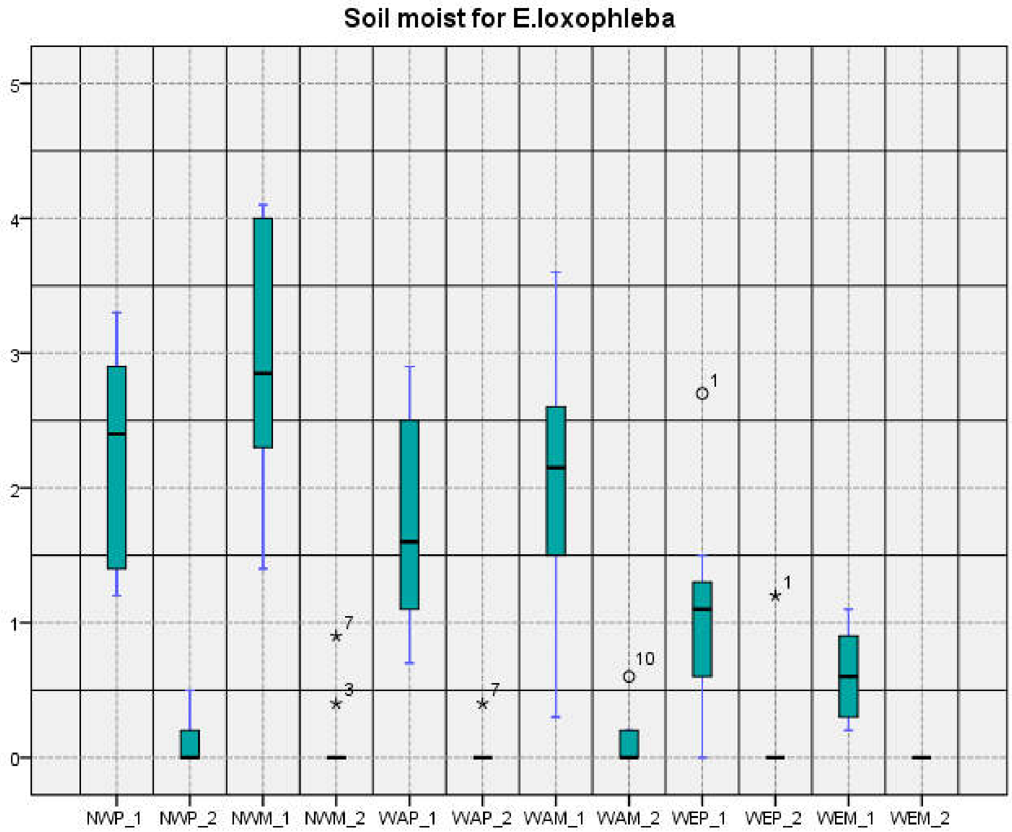


Figure 72. Soil moist for *E. loxophleba*