ALLELOPATHIC EFFECTS OF BANKRUPT BUSH (*Seriphium plumosum*) ON THE GERMINATION ABILITY OF SPECIFIC PLANT SPECIES

BY

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DECLARATION

I, Moketla Baltimore Mokou, do hereby declare that this mini-dissertation submitted to the University of Limpopo, for the Master of Science degree in Agriculture (Pasture Science) has not previously been submitted by me for a degree at this or any other university; it is my work in design and in execution, and all material contained herein has been duly acknowledged.

Mr Mokou MB	08/09/2016
Surname, Initials (title)	Date

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- Jesus Krist
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ABSTRACT

Seriphium plumosum is a declared indicator of bush encroachment, and poses a serious threat to the management of sustainable utilization in all grasslands. The successful invasiveness of *S. plumosum* is attributed to its competitive ability and high allelopathic potential. A trial was established at the University of Limpopo to investigate the interference between *S. plumosum* and four plant species, namely: *Eragrostis curvula*, *E. tef*, *Panicum maximum* and *Lactuca sativa*. Plant material of *S. plumosum* were collected and used to make infusions which were used on the receiver species.

The infusion inhibited the germination of all the receiver species, and it was highly significant ($P \leq 0.01$), compared to control treatments where no inhibition occurred. All receiver species were sensitive to roots and shoots infusions, but the effect of shoots infusion differed significantly ($P \leq 0.01$) from those of roots infusion. All receiver species were sensitive to both summer and winter collected materials, but plant material collected in winter had a bigger effect ($P \leq 0.01$) than plant material from summer. All receiver species were sensitive to both fresh and stored plant material, but inhibition effects were not statistically significantly different ($P \geq 0.05$).

All receiver species were sensitive to both fresh and stored soils collected in infested areas, but effects were not significantly different ($P \geq 0.05$), while the effects of infested and un-infested soils differed significantly ($P \leq 0.01$). All receiver species were sensitive to soils collected during summer and winter. Where infested soils were concerned, all receiver species were sensitive to infested soils, compared to control treatments where no effects occurred. Where stored infested soils were concerned, all receiver species were sensitive to both fresh and stored infested soils. It was concluded that both plant material of *S. plumosum* and soils from areas encroached by *S. plumosum* have a negative effect on seed germination of the four receiver species. Should a farmer control this species by means of cutting, it should be quickly removed to allow the gass to recover. The farmer must not expect quick recovery of grasses due to the presence of allelopathic substances in the soil.

CHAPTER 1
GENERAL INTRODUCTION

1.1 Background

The term *allelopathy* is from the Greek-derived compounds *allele* and *pathy* (meaning “mutual harm” or “suffering”), and was first used in 1937 by Austrian scientist Hans Molisch in the book “*Der Einflusseiner Pflanze auf dieandere – Allelopathie”* (*The Effect of Plants on Each Other*) (Willis, 2010). In his definition it refers to both detrimental and beneficial biochemical interactions among all classes of plants, including microorganisms. This has led to allelopathy being defined as: “any direct or indirect harmful or beneficial effect by one plant (including microorganisms) on another, through the production of chemical compounds that escape into the environment” (Kruse *et al*., 2000). Torres *et al*. (1996) further defined allelopathy as a process which involves the production of secondary metabolites by plants and microorganisms, which influence growth and development of biological systems.

It is believed that certain plants might have inhibitory effects on neighbouring plants by releasing allelopathic substances into the soil, either as exudates from the living tissues or as decomposing plant residues (Batlang and Shushu, 2007). It is believed that allelochemicals, are released into the environment by root exudation, leaching from aboveground parts, volatilisation and/or by decomposition of plant materials. These substances are known as allelochemicals, and can have beneficial (positive allelopathy) or detrimental (negative allelopathy) effects on the target organisms (Singh *et al*., 2003). They can be present in several plant parts, including roots, rhizomes, leaves, stems, pollen, seeds and flowers (Kruse *et al*., 2000).

The genus *Seriphium* consists of 36 species, with two species indigenous to Madagascar and 34 in South Africa, of which *Seriphium plumosum* is recognised as the most aggressive-growing species. Lately, this species is viewed as an encroacher in grasslands in South Africa (Snyman, 2010).

Seriphium plumosum is mainly found in the Limpopo Province, North West, Free State, Eastern Cape, Mpumalanga, Gauteng and certain parts of KwaZulu-Natal (Jordaan, 2009). *Seriphium plumosum* encroachment in South Africa has converted extensive areas of grassland into less productive shrubland-grassland (Snyman, 2010), and considerable economic inputs are made annually in South Africa on its chemical control (Jordaan, 2009). Little has been published on the physiological, phenological and ecological aspects of this plant species.

Seriphium plumosum encroachment has a devastating effect on the grazing capacity of veld. It causes land degradation which, in turn, leads to financial losses, since farmers are forced to obtain supplementary forage for livestock. The species is known for being very difficult to control, and of being extremely unpalatable for livestock and game animals. It is also highly flammable and aggravates the spread of uncontrolled veld fires, which makes it a problem plant in areas where it occurs (Snyman, 2009a).

The invasion of veld by *S. plumosum* is accompanied by competition among plants for resources such as light, water and nutrients (Vyvyan, 2002). Once an area is invaded by *S. plumosum*, it reduces its biodiversity, the function of the ecosystem is reduced and severe veld deterioration occurs (Singh *et al*., 2003). All aspects relating to the phenology and physiology of this problem species need investigation to develop a means of preventing its successful establishment and growth.

1.2. Purpose of the study

1.2.1 Aims

The aim of this study was to confirm and to establish which part of the plant is the main source of allelopathy.

1.2.2 Objectives

The objectives of this study were to:

i. Determine effect of plant material (roots and shoots) of *S. plumosum* on the germination percent and radicle length of specific receiver plant species.

ii. Determine effect of soil from an area encroached and not encroached by *S. plumosum* on the germination percent and radicle length of specific receiver plant species.

1.2.3 Research questions

i. Do different plant parts have an allelopathic effect on the germination of the receiver plant species?
ii. Is there a seasonal effect of allelopathy on the germination of the receiver plant species?
iii. Does stored plant material have a bigger effect than fresh plant material on the germination of the receiver plant species?
iv. Does soil from encroached area have a bigger effect than soil from unencroached area on the germination of the receiver plant species?
v. Does stored soil have a bigger effect than fresh soil on the germination of the receiver plant species?

1.2.4 Hypotheses

iii. Plant materials of *S. plumosum* had a negative effect on the germination percent and radicle length of specific plant species.
iv. Soil from areas encroached by *S. plumosum* had a negative effect on the germination percent and radicle length of specific plant species.

CHAPTER 2
LITERATURE REVIEW

2.1 General description of *Seriphium plumosum*

Seriphium plumosum is a small multi-stemmed woody shrub that grows to an average height of 1 m and a width of 0.6 m (Figure 2.1) (Schmidt *et al.,* 2002). The flowers (florets) are small, but are usually grouped together in an inflorescence that is called a head, which gives the appearance of being a single flower (Schmidt *et al*., 2002). The leaves are small, and grey-green (Wepener, 2007). Mature *S. plumosum* plants develop thickened rootstocks from which several stems grow. It is a declared indicator of bush encroachment and poses a serious threat to the management of sustainable utilization in all grasslands (Wepener, 2007).

Figure 2.1: *Seriphium plumosum* (bankrupt bush).

2.2 Distribution of *Seriphium plumosum*

The origin and causes of this encroacher plant will continue to be a controversial topic for a long time. The genus *Stoebe* consist of 34 species, occurring mainly in the Western Cape (25 species) but also in southern tropical Africa, Madagascar and Reunion. *Seriphium plumosum* is quite common and has a widespread distribution throughout South Africa (Acocks, 1988) (Figure 2.2).

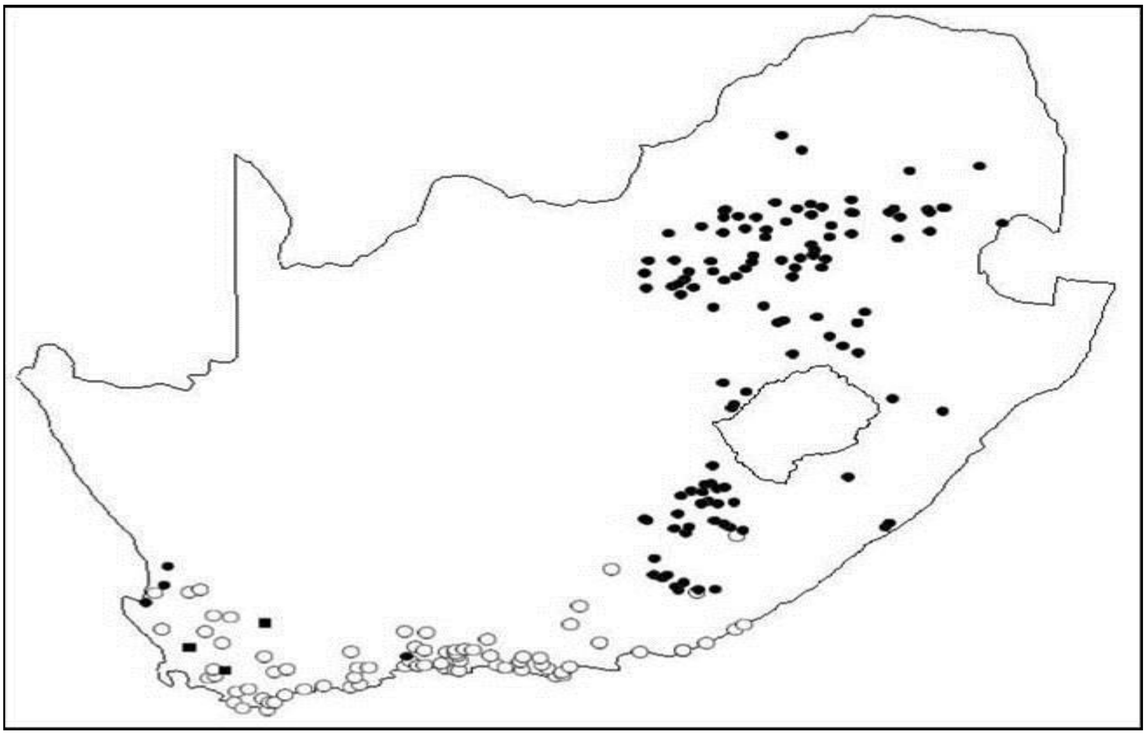


Figure 2.2: Distribution of *Seriphium plumosum* in South Africa (closed circles represents the species when it was classified as *Stoebe vulgaris*, open circles as *Stoebe plumosa* and closed squares as *Stoebe cinerea;* Acocks 1988).

The shrub belongs to the Asteraceae family. The genus was recently revised by Koekemoer (2002) and *Stoebe plumosa* was combined with other stoebes as *Seriphium plumosum*. The name *Seriphium* is derived from seriph, a stroke or line of a letter; *plumosum* means feathery (Badenhorst 2009). This shrub might be better known to many as *Stoebe vulgaris*. A common view is that *S. plumosum* evolved from *Stoebe cinerea* by mutations which changed its character and enabled it to invade the grassveld (Roux 1969). This encroachment severely decreases the grazing capacity of grasslands and decreases of up to 75 to 80% have already been found in certain parts of South Africa (Richter 1989).

2.3 Habitat of *Seriphium plumosum*

The plant occurs in mesic and semi-arid grasslands, in summer rainfall areas where the rainfall average is between 620 and 750 mm (Snyman, 2009b). It also occurs where veld is in a stage of secondary succession, for instance on abandoned agricultural lands in grassland regions, but it can also occur in climax veld. *Seriphium* *plumosum* is also abundant on rocky hill slopes and unploughed areas (Wepener, 2007).

The plant prefers sandy soils, and it does not grow well in heavy clay soils (Wepener, 2007). It is generally accepted to be mainly found on sandy, rocky soils with a low pH (Smit, 1955; Krupko and Davidson 1961). Soils with a clay content of up to 24% could still be encroached if the drainage is good, which could favor the establishment of this woody species. Very little is known of the actual germination and the conditions contributing towards its aggressive encroachment (Wepener, 2007).

2.4 Reproduction and establishment of *Seriphium plumosum*

Vegetative reproduction does not normally occur, and propagation occurs through seeds and seedlings. Flowering of *S. plumosum* occurs in autumn (March to May), and fruits mature in winter (May to June) (Snyman, 2009a). Each shrub produces thousands of seeds that are easily distributed by wind over large distances (Hattingh, 1953), though with a low germination and recruitment success (Snyman, 2008).

Establishment of *S*. *plumosum* often occurs where grazing and fire are excluded from old croplands as a result of low competition by grasses for water and nutrients, enabling the shrub to suppress the growth of grasses (Wepener, 2007).

2.5 The effect of *Seriphium plumosum* on veld

Although most literature refers to encroachment by larger woody plants (trees), many of the problems caused by woody shrub encroachment, and the principles regarding the control of this type of encroachment, are similar to those encountered when *S. plumosum* has encroached.

Land degradation is defined by the United Nations Convention to Combat Desertification (UNCCD) as a "reduction or loss, in arid, semi-arid, and dry sub-humid areas, of the biological or economic productivity and complexity of rain-fed cropland, irrigated cropland, or range, pasture, forest, and woodlands resulting from land uses, or from a process or combination of processes, including processes arising from human activities and habitation patterns, such as soil erosion caused by wind and/or water; deterioration of the physical, chemical, and biological or economic properties of soil; long-term loss of natural vegetation" (UNCCD, 1994). The encroachment by woody plants is, therefore, a form of land degradation.

Bush and alien vegetation encroachment (Figure 2.3) could be induced by human activities such as overgrazing, and wrongful fire management practices that cause an imbalance in the ratio between the herbaceous and woody component (UNEP, 1991). This could also lead to a loss in biodiversity (Smit, 2004), a lower grazing capacity, and ultimately a decrease in financial gain to the land user (Wepener, 2007).

Figure 2.3: Encroachment of *Seriphium plumosum*.

According to Trollope *et al*. (1989), encroachment could be defined as the invasion of undesirable plants in an area where it previously did not occur, or the aggregation of existing undesirable plants in an area. The encroachment of woody species was first recorded in the 1920's and 1930's in the savanna areas of the Limpopo Province and KwaZulu-Natal, and in the 1940's in the arid savanna of the Kalahari (Hoffman and Ashwell, 2001).

An evaluation of the extent of bush encroachment in 2001 on a 38 million ha area of veld in the non-communal areas of South Africa, indicated that 1.5 million ha was heavily encroached, and more than nine million ha was lightly to moderately encroached (Hoffman and Ashwell, 2001). Aucamp *et al*. (1983), found that at *A.*

karroo densities of 1 000, 1 500 and 2000 tree equivalents/ha, the grazing capacity of the veld can be expected to be 90%, 67% and 32% of its potential, respectively. It was believed that dense *S*. *plumosum* stands of 10 000 plants per hectare could reduce the grass production by as much as 75% (Richter, 1989).

The driving force behind bush encroachment is not well understood, but often associated with overgrazing and poor veld management. Other factors include increased rainfall, fire suppression, soil characteristics, and increased levels of atmospheric carbon dioxide (Richter, 1989). According to Richter (1989), several reasons have been proposed as major causes of the encroachment of woody shrub species, which include overgrazing due to high stocking rates, incorrect management practices and severe droughts. However, it is also important to note that, when the canopy cover of woody species is reduced through shrub eradication, it leaves gaps that are prone to wind erosion, as well as higher water runoff due to a loss in grass basal cover. To maintain a vigorous grass cover, sound veld management practices are of the utmost importance after the clearing process (Rango *et al.,* 2005).

2.6 Allelopathy

2.6.1 Allelopathy in general

Seed germination tests have been a widely used bioassay for the determination of allelopathic activity (Chiapusio *et al*., 1997). This method has served to validate (or reject) allelopathy in ecosystems or agrosystems. For instance, effects of phenolic acids on seed germination and seedling growth in soils were contested by Krogmeier and Bremmer (1989) and by Kaminsky (1981). In contrast, the same method was used successfully by to describe allelopathic inhibition of spruce germination and seedling growth by humic phenols. Thus, the relevance of seed germination bioassays in allelopathy research must be given attention. However, the manner in which these bioassays are conducted has to be carefully considered (Pellissier, 1993).

Optimal germination conditions are different for each species (dormancy, temperature, photoperiod, and volume of solution per petri dish) and must be well identified (Chiapusio *et al*., 1997). In addition, it is important to use suitable indices of germination. In many investigations different indices were used to show allelelochemical effects on germination. The indices are usually of three types: maximum germination percentage (also termed germination capacity), germination progress, and shape of the germination curve (Chiapusio *et al*., 1997).

A plant with allelopathic potential is referred to as the "donor plant," while the plant in the vicinity affected by the allelopathic compounds from the donor plant is referred to as the "receiver plant." Donor and receiver plants can affect each other through allelopathy and competition. The combined effect of these two interactions has been termed "interference" (Wu *et al*., 2001).

Allelochemicals belong to “secondary metabolites” or dispensable constituents in plants. It exists only in the plant kingdom (Fujii and Hiradate, 2007). In the past, the purpose of these chemicals in plants seemed to be a pool of energy or reducing agents, or simple wastes. Recently, the allelopathy hypothesis described the real meaning of these secondary metabolites as a tool of immobile plants to protect themselves from surrounding plants or other life that might attack them, or a tool to communicate with each other or with other life for their survival (Fujii and Hiradate, 2007).

Allelopathic inhibition is complex and can involve the interaction of different classes of chemicals, such as phenolic compounds, flavonoids, terpenoids, alkaloids, steroids, carbohydrates, and amino acids, with mixtures of different compounds sometimes having a greater allelopathic effect than individual compounds alone. Flavonoids have frequently been implicated in inhibiting seed germination and root growth (Batlang and Shushu, 2007). Phenolic compounds have also been shown to inhibit germination and growth of many plants (Weir *et al*., 2003).

Allelopathic compounds are divided into 14 chemical categories: (a) cinnamic acid derivatives, (b) coumarins, (c) simple phenols, benzoic acid derivatives, gallic acid and protocatechuic acid, (d) flavonoids, (e) condensed and hydrolizable tannins, (f) terpenoids and steroids, (g) water soluble organic acids, straight chain alcohols, aliphatic aldehydes and ketones, (h) simple unsaturated lactones, (i) longer chain fatty acids, (j) naphthoquinones, anthraquinones and complex quinones, (k) aminoacids and polypeptides, (l) alkaloids and cyanohydrins, (m) sulfides and mustardoil glycosides and (n) purines and nucleotides.

However, Putnam and Tang (1986) grouped these chemicals into 11 classes: (a) toxic gases, (b) organic acids and aldehydes, (c) aromatic acids, (d) simple unsaturated lactones, (e) coumarins, (f) quinines, (g) flavonoids, (h) tannins, (i) alkaloids, (j) terpenoids and steroids, and (k) miscellaneous and unknown.

Radiation, mineral deficiencies, water stress, temperature, allelopathic agents, age of plant organs, genetics, pathogens and predators are regarded as factors which determine the amount of allelochemicals that plants produce. Furthermore, physiological and environmental stresses, pests and diseases, solar radiation, herbicides, and less than optimal nutrient, moisture, and temperature levels can also affect allelopathic actions. Like synthetic herbicides, there is no common mode of action or a physiological target site for all allelochemicals. However, known sites of action for some allelochemicals include cell division, pollen germination, nutrient uptake, photosynthesis, and specific enzyme function (Batlang and Shushu, 2007).

2.6.2 Plant parts

The allelochemicals could be presented in every organ of plant parts, including flowers, leaves, stems, roots and seeds (Fateh *et al*., 2012; Grisi *et al*., 2012). Naderi and Bijanzadeh (2012) identified the potential of allelopathic effects of leaf, stem and root extracts of ten Iranian rice cultivars on barnyard grass. Leaf extract exhibited the strongest growth inhibitory activity, followed by root and stem extracts. Numerous researchers also reported that each plant part had significantly different effects on the growth of test plant species (Liu *et al*., 2003; Dorning and Cipollini, 2006; Fateh *et al*., 2012; Grisi *et al*., 2012; Pirzad *et al*., 2012; Tabrizi and Yarnia, 2011). It has also been reported that the compounds in roots of donor plants are better distributed to roots of receiver plants than the compounds in leaves (Wu *et al*., 2009).

2.6.3 Soil

Allelopathic chemicals or allelochemicals, derived from roots and plant leachates can also persist in soil, affecting both neighbouring plants as well as those planted in succession (Inderjit, 1998).

Apart from the direct effect toxic effect on other plants, some allelochemicals can also influence the availability of nutrients in the soil. It has been hypothesized that allelopathic plants, in addition to qualitative and quantitative changes in the soil content of allelochemicals, also might cause changes in soil chemical characteristics (Inderjit, 1998). Phenolic compounds have been reported to play a major allelochemical role in wide range of plant species (Kuiters and Sarink, 1986; Seal *et al*., 2004; Belz, 2007). They can be released into soils as root exudates, leaf leachates and products of plant tissue decomposition (Macı´as *et al*., 2007).

2.7 Overview of receiver species used

Many species are used in bioassays to indicate allelopathic activity (Wu *et al*., 2001). Some standard indicator species, such as lettuce (*Lactuca sativa*), radish (*Raphanus sativa*), and duckweed (*Lemna minor*), have been recommended for the preliminary testing of allelopathic activity because of their availability and high sensitivity to allelopathic actions (Wu *et al*., 2001). In this study the following receiver species were used to test the allelopathic effects of *S. plumosum*: *Lactuca sativa*, *Eragrostis curvula*, *Eragrostis tef* and *Panicum maximum*.

2.7.1 Overview of *Lectuca sativa*

The germination of lettuce seed (*L. sativa*) is inhibited at temperatures above 25 °C. However, these temperatures might not prevent growth of seeds, which have already started to germinate. This inhibition seems to be largely a varietal characteristic, for the temperature at which one variety will germinate satisfactorily may completely inhibit the germination of another variety. Furthermore, it usually requires a higher temperature to inhibit the germination of old seed than it does that of freshly harvested seed of the same variety (Borthwick and Robbins, 1928).

The requirements for the germination of lettuce seed are an adequate supply of moisture, a low temperature (below 25 °C) and good aeration. Coats surrounding the embryo do not limit the uptake of water. Seeds absorb sufficient water for germination from four to six hours. High percentages of germination are secured over a wide temperature range, from 1 to 25 °C. At temperatures between 25 °C and 30 °C, most varieties of lettuce rapidly decline in percentage germination. At 30 °C, in most varieties, germination is almost entirely inhibited (Borthwick and Robbins, 1928).

2.7.2 Overview of *Eragrostis curvula*

Eragrostis curvula (Weeping lovegrass) is a relatively good seed producer. The majority of seed heads in an *E. curvula* seed crop emerge over a period of 18 to 20 days. Seeds are therefore likely to ripen over an extended period of time. The most appropriate time to harvest the crop is thus not clearly defined. An understanding of the relative contribution of the different inflorescence emergence groups to total yield would assist, considerably in the decision on when to harvest the crop (Field-Dogdson, 1976).

Seeds usually germinate whenever sufficient soil moisture is available (Parsons and Cuthbertson, 2001). Seeds germinate over a wide range of temperature and soil moisture regimes (Maze *et al*., 1993). Germination is poor on clay soils compared to sandy soils (Leigh and Davidson, 1968). In experimental conditions, seeds required two days of high soil moisture (with at least 10 mm of water available over this time), for seedlings to emerge in previously dry sandy soil at temperatures of 24 – 30 ˚C and there was no emergence at 38 ˚C (Wester *et al*., 1986).

Seedlings reach varying degrees of maturity during their first year of growth, with flowers produced in the first or second year, depending on soil and environmental conditions (Shoop and McIlvain, 1970). Growth is strongly temperature-dependent, with germination occurring any time when temperatures exceed 10 ˚C, and stem and seed production is continuous in warmer zones (Parsons and Cuthbertson, 2001). During the first three weeks of growth, seedlings consist of a single stranded ‘seed root’ with just a few small branchlets and are highly susceptible to disturbance. The permanent ‘crown root’ starts to develop after this, the seed root disappearing by about the eighth week of growth (Shoop and McIlvain, 1970). Johnston and Shoemark (1997) demonstrated that two cultivars of *E. curvula*, 'Consol' and 'Accession 4660', had an ability to delay establishment until conditions became favorable for germination.

2.7.3 Overview of *Eragrostis tef*

Eragrostis tef (Teff) is an annual hay grass. On occasions it is used for grazing as well. It is very leafy and has fine stems, making it an excellent grass for hay production. Germination of Teff normally takes place 4 days after sowing. In germination studies, germination was above 90% at temperatures of 15 – 35 °C while no germination occurred at 10 °C. A booting stage is not noticeable in Teff: the inflorescences emerge from the upper leaf sheath without boot formation. The flowers open in the morning (7 - 9 am) in response to light and temperature (Tefera and Belay, 2006).

Teff is predominantly self-pollinating, with a very low degree of outcrossing (up to 1%), and pollen is set free in the early morning. In the inflorescence floral maturity starts from the top and progresses downward, whereas in the spikelet it progresses from the base upward. Seeds mature within a month after pollination. The total growth cycle from sowing to maturity is 2 - 5 months. Teff follows the C_4 - photosynthetic pathway (Tefera and Belay, 2006).

2.7.4 Overview of *Panicum maximum*

Panicum maximum (White buffalo grass/Guinea grass) is a clump-forming perennial, which grows best in warm frost-free areas. It grows in tropical and subtropical areas, under varying rainfall conditions on a wide range of soils (Aganga and Tshwenyane, 2004). The deep, dense and fibrous root system allows *P. maximum* to survive long drought periods, but it performs best on well-drained soils of good fertility in high rainfall regions (Humphreys and Partridge, 1995). It is most frequently found in open woodland (Botha and Botha 1996).

Panicum maximum is probably the most valuable grazing grass in its distribution range, and it is particularly palatable. This grass can easily be cultivated from seed that is obtainable from seed distributors. Sow seed in spring and early summer in fertile, well-prepared soil. It prefers shade and damp areas, and will do well under trees and shrubs. If the grass is already established and conditions are favourable, it will multiply quickly and form a luxuriant growth (Botha and Botha 1996).

CHAPTER 3

THE EFFECT OF FRESH ROOT AND SHOOT EXTRACTS OF *SERIPHIUM PLUMOSUM* AS AN ALLELOPATHIC AGENT

3.1 Introduction

In 2008, Snyman reported that allelopathically *S. plumosum* prevented seed of other species such as *L. sativa* from germinating and developing close to the parent plant. Wind-pollinated plants, of which *S. plumosum* is a good example, usually have this allelopathic characteristic (Van Wyk, 2004). The allelochemicals could be present in every organ of plant parts (Fateh *et al*., 2012; Grisi *et al*., 2012). According to Naderi and Bijanzadeh (2012), leaves of *S. plumosum* have the strongest growth inhibitory activity, followed by roots and stems. However, different plant parts could have different effects on the growth of receiver plant species (Fateh *et al*., 2012; Grisi *et al*., 2012; Pirzad *et al*., 2012). Snyman (2010) found that high-concentration of *S. plumosum* extracts derived from fresh roots and shoots materials had a greater effect on the germination of dicot species such as *L. sativa*.

3.2 Methodology

3.2.1 Collecting plant material

Roots and shoots of S. plumosum were collected at the Mabula Private Game Reserve, which is situated approximately 45 km north west of the town Bela-Bela in the Limpopo Province (24°42’S and 24°50’S and 27º50 E and 27º58 E). The altitude ranges between 1140 and 1432 metres above sea level.

The reserve occupies an area of 8500 ha and is situated in the savanna biome (Low and Rebelo, 1996). Soils at Mabula can be classified into two main types. Soils originating from igneous rock (granites) occur in the southeast of the reserve, and soils originating from sedimentary rocks (arinitic rocks) in the north-west. Soils from igneous rocks generally have a higher pH, and are less leached than soils from a sedimentary origin. Red soils at Mabula indicate better drainage and aeration with red oxidation layering around the grains. The majority of soils at Mabula are of a sandy texture with less than 15% clay. The clay content increases in low-lying areas, due to the natural process of accumulation of finer material in areas with smaller gradients (Kriel, 2000).

Mabula has a unimodal, subtropical savanna climate (Low and Rabelo, 1996). The mean annual rainfall is 611.3 mm. The rainfall is seasonal, with the majority of precipitation occurring during the warmer months (September to April). The coolest month is June, with a mean monthly maximum temperature of 12.7 °C. The warmest month is January, with a mean monthly temperature of 23.3 °C (ISCW, 2007).

Plant material (shoots and root material) of *S. plumosum* were collected from 30 randomly chosen plants in an area, situated in the south-eastern part of the Mabula Private Game Reserve that was severely encroached by *S. plumosum*, during summer and winter month of 2014. At the collection site, the vegetation are classified as Sour and Mixed Bushveld (Acocks, 1988). Dominant grasses are *Hyperthelia dissoluta, Heteropogon contortus, Digitaria eriantha, Eragrostis* species and *Melenis repens*, while a woody component such as *Vachillia* and *Senegalia* species (*Acacia* species)*, Dichrostachys cinera* and *Terminalia sericea* occur (Smallwood, 2007).

3.2.2 Determining allelopathic effects

This study was conducted at the Plant Production at the University of Limpopo (23º53′10″S, 29º44′15″E). The influence of the possible allelopathic effect of *S. plumosum* was tested on the following plant species:

i. *Lactuca sativa* (Lettuce)
ii. *Eragrostis curvula* (Weeping lovegrass)
iii. *Eragrostis tef* (Teff)
iv. *Panicum maximum* (White buffalo grass)

The three grasses were selected because they were inherently different in terms of growth form, vigor, life cycles and adaptability. *Lactuca sativa* was selected because of its high sensitivity to allelochemicals.

The experimental layout was a 2 X 2 X 2 factorial, in a randomized block design, replicated four times.

Plant materials of *S. plumosum* were collected during the summer of 2014 and separated into root and shoot material. The materials were chopped and finely grinded, and each soaked in distilled water as solvent (150 g of shoots in 2000 ml of distilled water, and 150 g of roots in 2000 ml of distilled water). The soaking process was done at room temperature for 24 hours to produce aqueous extracts of the different plant parts.

The experiment thus consisted of the following treatments:

- Distilled water only as a control treatment (roots collected in summer)
- An infusion of roots collected in summer
- Distilled water only as a control treatment (roots collected in winter)
- An infusion of roots collected in winter
- Distilled water only as a control treatment (shoots collected in summer)
- An infusion of shoots collected in summer
- Distilled water only as a control treatment (shoots collected in winter)
- An infusion of shoots collected in winter

In a pilot study, to determine the concentration of allelochemicals in the infusion, a sample of the infusion was analyzed at the Biochemistry Laboratory of the University of Limpopo, using a modern HPLC system. In total, 82 different unidentified compounds were noted, each possibly responsible for the allelopathic action of *S. plumosum*. Periodic peaks in allelochemical production have been reported, especially in response to biotic factors, but due to the complexity of the relevant allelochemicals involved, little is known about the alleochemicals themselves, and the concentrations required to inhibit plant growth and seedling emergence (Snyman, 2010). The pilot study supported these findings. Therefore, for the purpose of this study, the allelopathic potential of *S. plumosum* was investigated using only the effects of the infusions at an unknown concentration of the allelopathic agent.

Fresh certified seeds of each of the receiver species were bought from Hygrotech Seed Company. Fifty seeds of each of the receiver species were placed in petri dishes lined with Whatmann number one filter paper, and treated with 3 ml of the roots and shoots extracts. Distilled water was used as a control. The petri dishes were sealed with cling wrap and placed in a germination chamber. The chamber was set to 90% humidity with all lights on for 12 hours during the day and off for 12 hours during the night, limited to a 25 °C dewpoint temperature, for a period of seven to 21 days.

3.2.3 Data collection

Data collection included the following:

i. Counting seedlings of each receiver species that germinated. This was done on a daily basis from the day of planting for a period of seven to 21 days, the aim being to determine the number of days to first and maximum germination, and to determine the germination percentage.
ii. Measuring the radicle length of seedlings after germination. Four seedlings were selected randomly per receiver species in each petri dish. The radicle length was measured, using a 300 mm ruler.

3.2.4 Data analysis

Generalized linear model (GLM) analysis was applied to the number of days to first germination and to the number of days to maximum germination with the Poisson distribution (for counts) and logarithmic link function, testing for differences between the effects of two plant parts, two seasons and two concentrations of infusions, as well as all their interactions.

Germination percentage data was analysed in the same way with GLM, but with the Binomial distribution (for proportions) and the logit link function, testing for differences between the effects of two plant parts, two seasons and two infusions, as well as all their interactions.

The radicle lengths were positively skewed, and therefore analysed with GLM and the Gamma distribution, testing for differences between the effects of two plant parts, two seasons and two infusions, as well as all their interactions.

All predictions were compared with Fisher's protected least significant test at the 5% level ($P \leq 0.05$). Data were analysed using the statistical program GenStat® (Payne, 2014).

3.3 Results

Please note that only factors that were significant are illustrated graphically.

3.3.1 *Lactuca sativa*

3.3.1.1 Days to first germination

Days to first germination were highly significant ($P \leq 0.01$; Figure 3.1 and Figure 3.2) between infusions and the interaction between infusions and plant parts (Annexure A - Table A1.1.2). All other factors, including plant parts and season as main factors were not significant. Infusions [(37.522/150.387) x 100 = 24.95%] and the interaction between plant parts and infusions [(33.128/150.387) x 100 = 22.03%] comprised 46.98% of the total deviance. Significant differences occurred between the infusions (Table A1.1.3), but where interaction between infusions and plant parts were concerned, only the shoots infusion was significantly different from others (Table A1.1.5).

In the two control treatments that represented roots and shoots collected in summer, *Lactuca sativa* started germinating on day 5, while it started germinating on day 6 in the two control treatments that represented plant material collected in winter.

Lactuca sativa started germinating on day 3 where the roots infusion collected in summer was applied, but did not germinate where the shoots infusion collected in summer was applied (Table 3.1). Similarly, *L. sativa* started germinating day on 4 where the infusion of roots collected in winter was applied, but did not germinate where the infusion of shoots collected in winter was applied (Table 3.1).

3.3.1.2 Days to maximum germination

Differences in days to maximum germination were highly significant ($P \leq 0.01$; Figure 3.3 and Figure 3.4) between infusions and the interaction between infusions and plant parts (Annexure A - Table A1.2.2). All other factors, including plant parts and season as main factors, were not significant ($P \geq 0.05$). Infusions [(158.165/271.724) x 100 = 58.21%] and the interaction between plant parts and infusions [(34.318/271.724) x 100 = 12.63%] comprised 70.84% of the total deviance.

Significant differences occurred between the infusions (Annexure A - Table A1.2.3), but where interaction between infusions and plant parts were concerned, the shoots infusion was significantly different from the root infusion and both the root and shoot infusions were significantly different to the control treatments (Annexure A - Table A1.2.5).

In the control treatments, *L. sativa* reached maximum germination on day 14 in treatments that represented infusions from roots and shoots collected in summer and on day 12 in treatments that represented roots and shoots material collected in winter. It did not germinate where the shoots infusion of material collected in summer was applied (Table 3.1), but reached maximum germination on day 4 where the infusion of roots collected in summer was applied. *Lactuca sativa* reached maximum germination on day 4 where the infusion in roots collected in winter was applied, and did not germinate where the infusion of shoots collected in winter was applied (Table 3.1).

3.3.1.3 Germination percentage

Differences in germination percentage were highly significant ($P \leq 0.01$; Figure 3.5, Figure 3.6 and Figure 3.7) between infusions, plant parts and seasons (Annexure A - Table A1.3.2). All other factors were not significant ($P \geq 0.05$). Infusions (97.96%), plant parts (0.39%) and season (0.32%) comprised 98.67% of the total deviance. Significant differences occurred between the infusions (Annexure A - Table A1.3.3) and between plant parts (Annexure A - Table A1.3.4) as well as between seasons (Annexure A - Table A1.3.5).

Lactuca sativa reached maximum a germination percentage of 1% with the infusion in roots collected in summer and 0% with the infusion of shoots collected in summer (Table 3.1). *Lactuca sativa* had a germination percentage of 1% with the infusion of roots collected in winter and 0% with the infusion of shoots collected in winter (Table 3.1).

In the control treatments, *L. sativa* had a similar germination percentage, namely of 94%, in treatments that represented infusions from roots and shoots collected in summer and winter. Treatments that involved root infusions, 1% germination was obtained, while no germination occurred in either of the shoots infusion treatments (Table 3.1).

3.3.1.4 Radicle length

Differences in radicle length were highly significant ($P \leq 0.01$; Figure 3.8, Figure 3.9 and Figure 3.10) between infusions, the interaction between infusions and plant parts and the interaction between plant parts and seasons (Annexure A - Table A1.4.2). Plant parts and seasons as the main factors were significant ($P \leq 0.05$ Figure 3.11 and Figure 3.12). All other factors were not significant ($P \geq 0.05$). Infusions (85.10%), plant parts (1.43%), season (1.20%), the interaction between plant parts and infusions (1.80%) and the interaction between plant parts and season (3.64%) comprised 93.17% of the total deviance.

Significant differences occurred between the infusions (Annexure A - Table A1.4.3) and between plant parts (Annexure A - Table A1.4.4) as well as between seasons (Annexure A - Table A1.4.6). However, where the interaction between plant parts and infusions were concerned, the roots and shoots infusions were significantly different from the control treatments and they were also significantly different from each other (Annexure A - Table A1.4.5).

In all the control treatments, *L. sativa* reached a radicle length of 31 mm when the germination study ended after 21 days (in both treatments that represented infusions from roots and shoots, collected in both summer and winter) (Table 3.1). With the root infusion (summer and winter collected), the average radicle length was 1 mm, while with shoot infusions was 0 mm (Table 3.1).

Overall, the infusion had a major depressing effect on days to first and maximum germination, as well as on the germination percentage and radicle length, compared to the control treatment.

Where plant parts were concerned, both the shoots and roots infusion had similar inhibitory effects on days to first and maximum germination, but the shoots infusion had a bigger effect on the germination percentage and radicle length, compared to the roots infusions.

Where seasons were concerned, summer and winter infusions had similar inhibitory effects on days to first and maximum germination, but summer material had a bigger inhibitory effect on the germination percentage as well as on radicle length.

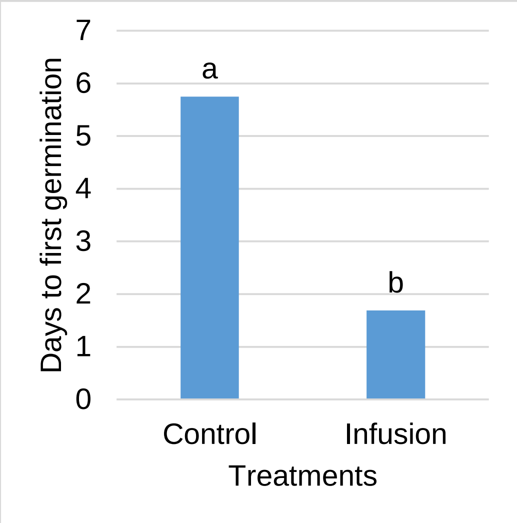


Figure 3.1: Mean comparison for the effect of infusions on days to first germination of *Lactuca sativa*.

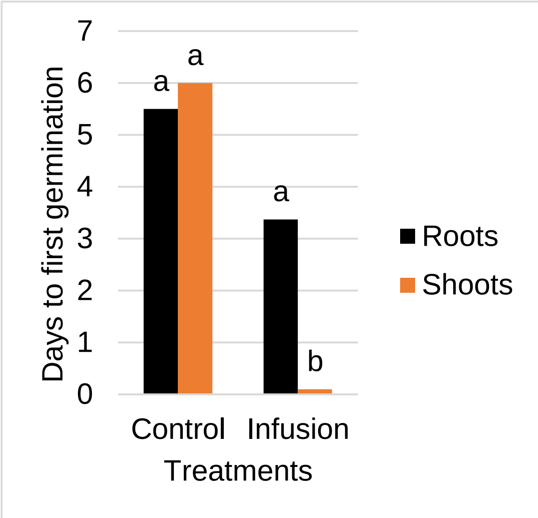


Figure 3.2: Mean comparison for the interaction between infusions and plant parts on days to first germination of *Lactuca sativa*.

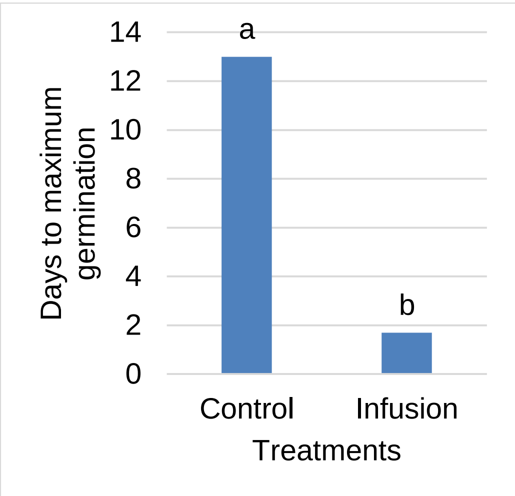


Figure 3.3: Mean comparison for the effect of infusions on days to maximum germination of *Lactuca sativa*.

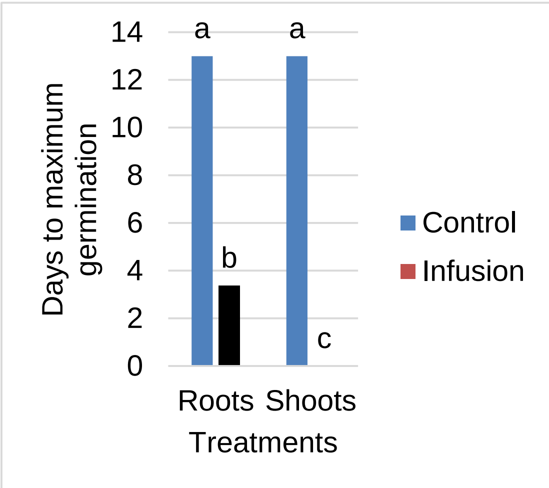


Figure 3.4: Mean comparison for the interaction between infusions and plant parts on days to maximum germination of *Lactuca sativa*.

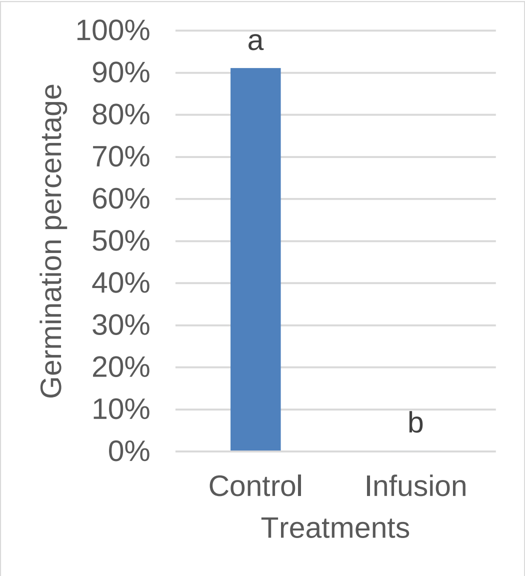


Figure 3.5: Mean comparison for the effect of infusions on the germination percentage of *Lactuca sativa*.

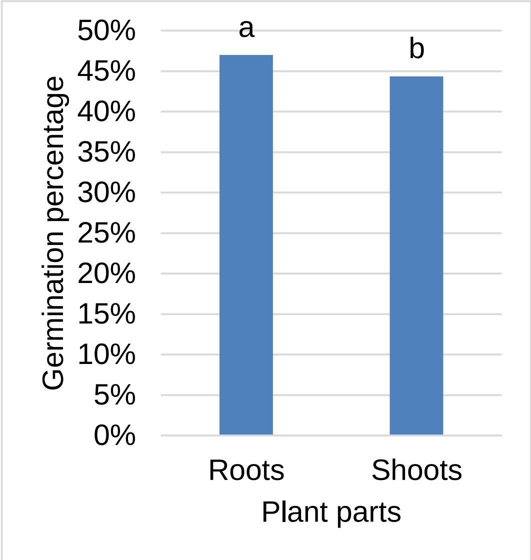


Figure 3.6: Mean comparison for the effect of plant parts on the germination percentage of *Lactuca sativa*.

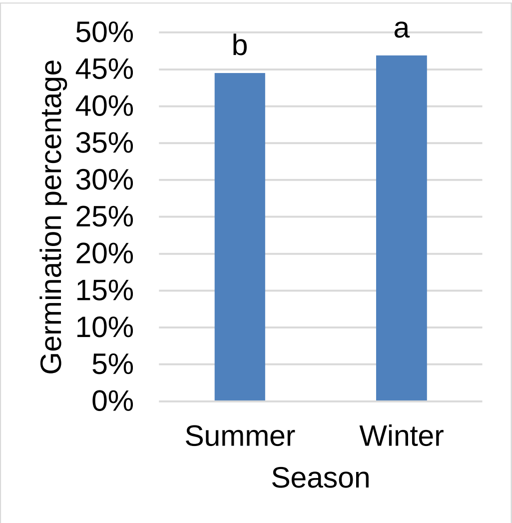


Figure 3.7: Mean comparison for the effect of season on the germination percentage of *Lactuca sativa*.

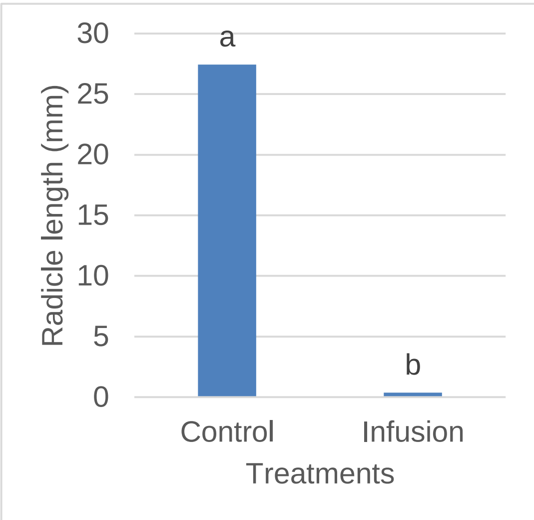


Figure 3.8: Mean comparison for the effect of infusions on the radicle length of *Lactuca sativa*.

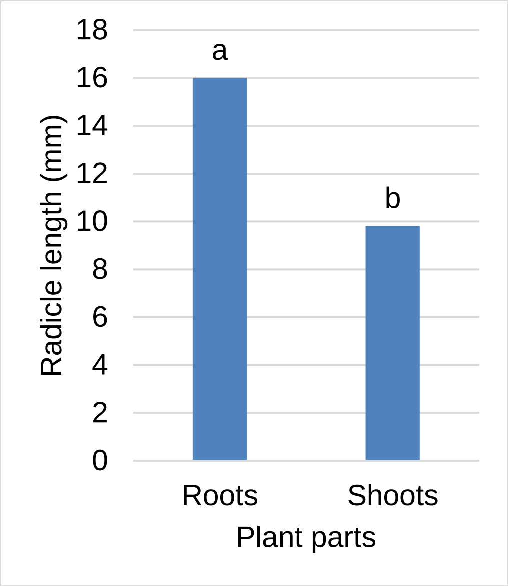


Figure 3.9: Mean comparison for the effect of plant parts on the radicle length of *Lactuca sativa*.

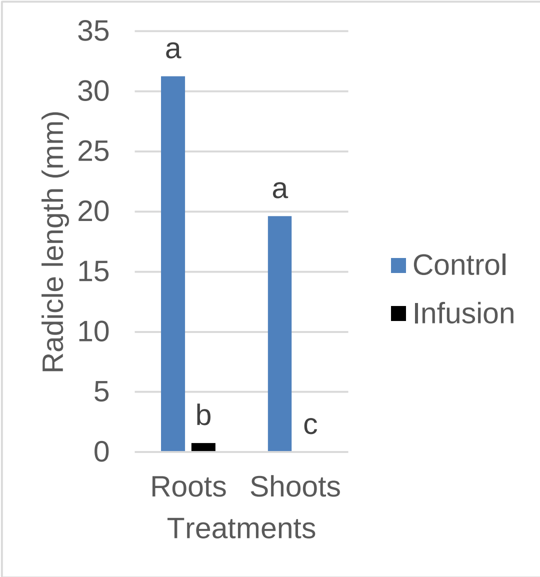


Figure 3.10: Mean comparison for the interaction between infusions and plant parts on the radicle length of *Lactuca sativa*.

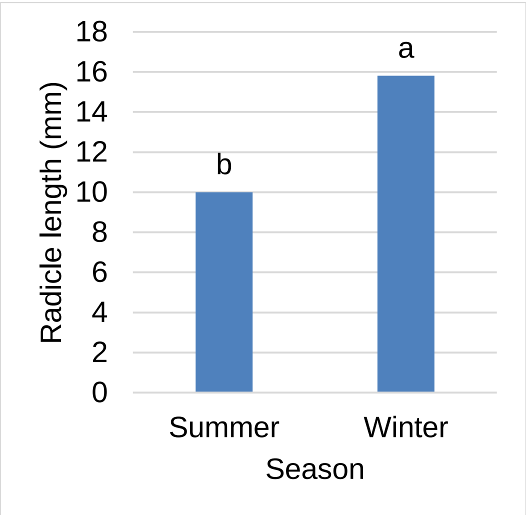


Figure 3.11: Mean comparison for the effect of season on the radicle length of *Lactuca sativa*.

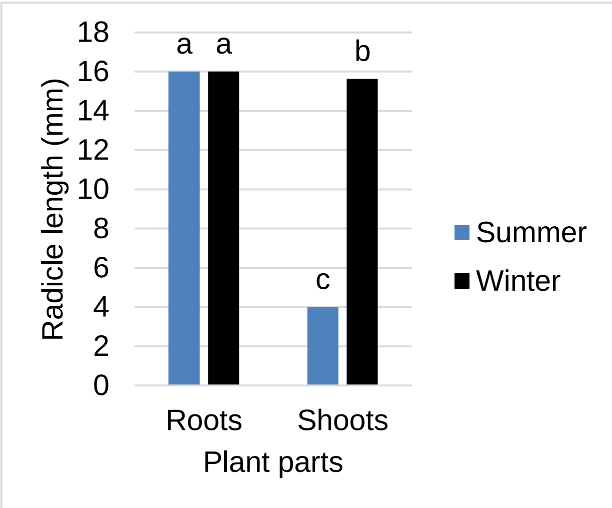


Figure 3.12: Mean comparison for the interaction between season and plant parts on the radicle length of *Lactuca sativa*.

3.3.2 *Eragrostis curvula*

3.3.2.1 Days to first germination

All treatments and interaction were not significant ($P \geq 0.05$) (Annexure A - Table A2.1.2). In the two control treatments that represented roots and shoots collected in summer, *E. curvula* started germinating on day 6 while it started germinating on day 7 in the control treatment that represented roots and shoots collected in winter. *Eragrostis curvula* started germinating on day 9 where the roots infusion collected in summer was applied, but it started germinating on day 5 where the shoots infusion collected in summer was applied (Table 3.1). Similarly, *E. curvula* started germinating on day 11 where the roots infusion collected in winter was applied, but started germinating on day 6 where the shoots infusion collected in winter was applied (Table 3.1)

3.3.2.2 Days to maximum germination

There was no significant difference ($P \geq 0.05$) between treatments, including plant parts and season and infusions as main factors (Annexure A - Table A2.2.2). In the two control treatments that represented roots and shoots collected in summer (distilled water only), *E. curvula* reached maximum germination on day 14, and on day 15 in treatments that represented roots and shoots collected in winter (Table 3.1). *Eragrostis curvula* reached maximum germination on day 14 where the roots infusion collected in summer was applied, but reached maximum germination on day 8 where the shoots infusion collected in summer was applied (Table 3.1). Similarly, *E. curvula* reached maximum germination on day 16, where both the roots and shoots infusions collected in winter were applied (Table 3.1).

3.3.2.3 Germination percentage

The differences in germination percentage were highly significant ($P \leq 0.01$; Figure 3.13, Figure 3.14 and Figure 3.15) between infusions, plant parts and the interaction between infusions and plant parts (Annexure A - Table A2.3.2). All other factors were not significant ($P \geq 0.05$), including season as the main factor. Infusions (93.62%), plant parts (0.94%) and the interaction between infusions and plant parts (1.73%)

comprised 96.29% of the total deviance. Significant differences occurred between the infusions (Annexure A - Table A2.3.3) and plant parts (Annexure A - Table A2.3.4). However, where the interaction between plant parts and infusions were concerned, the roots and shoots infusions of were significantly different from the control treatments and they were also significantly different from each other (Annexure A - Table A2.3.5).

In the control treatments, *E. curvula* had a similar germination percentages, namely 84% in treatment that represented infusions from roots and shoots collected in summer. *Eragrostis curvula* had a germination percentage of 14% in the roots infusion collected in summer, but 4% in the shoots infusion collected in summer (Table 3.1). Similarly, *E. curvula* had a germination percentage of 80% in treatments that represented infusions from roots collected in winter, but 84% in treatments that represented infusions from shoots collected in winter. *Eragrostis curvula* had a germination percentage of 14% in roots infusion collected in winter, but 4% in shoots infusion collected in winter (Table 3.1).

3.3.2.4 Radicle length

Differences in radicle length were highly significant ($P \leq 0.01$; Figure 3.16) between infusions (Annexure A - Table A2.4.2). The interaction between infusions and plant parts was significant ($P \leq 0.05$; Figure 3.17). All other factors were not significant ($P \geq 0.05$), including plant parts as the main factor. Infusions (66.56%) and the interaction between plant parts and infusions (5.40%) comprised 71.96% of the total deviance. Significant differences occurred between the infusions (Annexure A - Table A2.4.3). However where the interaction between plant parts and infusions were concerned the roots and shoots infusions of were significantly different from the control treatments and they were also significantly different from each other (Annexure A - Table A2.4.5).

Eragrostis curvula reached a radicle length of 8 mm in the control treatments that represented the roots and shoots materials collected in summer. *Eragrostis curvula* reached a radicle length of 2 mm with the roots infusion collected in summer, but only 1 mm with the shoots infusion collected in summer (Table 3.1). *Eragrostis curvula* reached a radicle length of 11 mm in the control treatments that represented the roots materials collected in winter, but reached a radicle length of 8 mm in the control treatments that represented the shoots materials collected in winter. *Eragrostis curvula* reached a radicle length of 2 mm with the roots infusion collected in winter, but reached a radicle length of 1 mm with the shoots infusion collected in winter (Table 3.1).

The control treatments and the infusions had similar inhibitory effects on days to first and maximum germination, but the infusion had a bigger effect on the germination percentage and radicle length, compared to the control treatments.

Where plant parts were concerned, the shoots and roots infusion had similar inhibitory effects on days to first and maximum germination, but the shoots infusion had a bigger effect on the germination percentage. Both the roots and shoots infusion had similar inhibitory effects on radicle length.

Where seasons were concerned, summer and winter infusions had similar inhibitory effects on days to first and maximum germination, as well as on maximum germination percentage and radicle length.

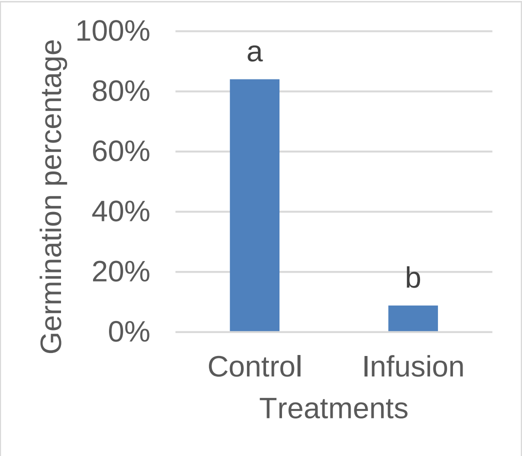


Figure 3.13: Mean comparison for the effect of infusions on the germination percentage of *Eragrostis curvula*.

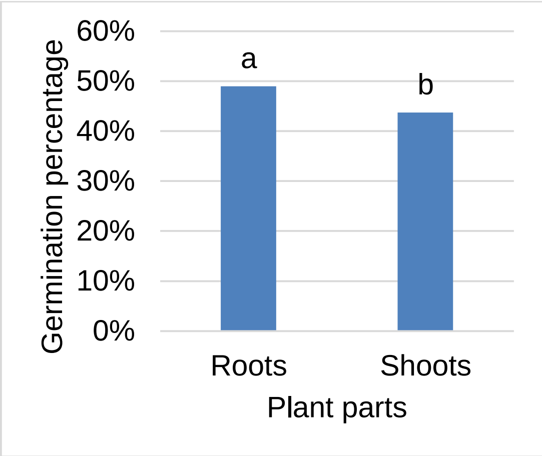


Figure 3.14: Mean comparison for the effect of plant parts on the germination percentage of *Eragrostis curvula*.

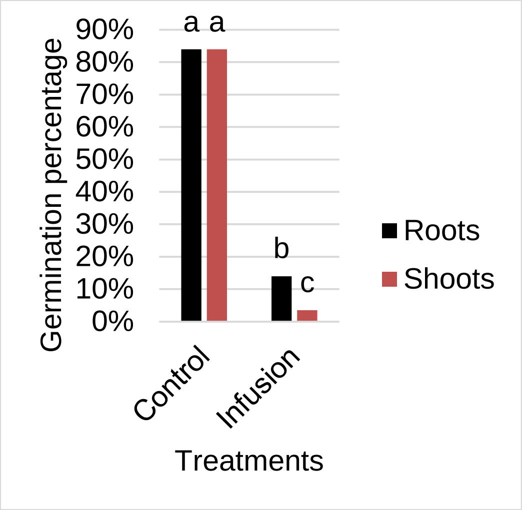


Figure 3.15: Mean comparison for the interaction between infusions and plant parts on the germination percentage of *Eragrostis curvula*.

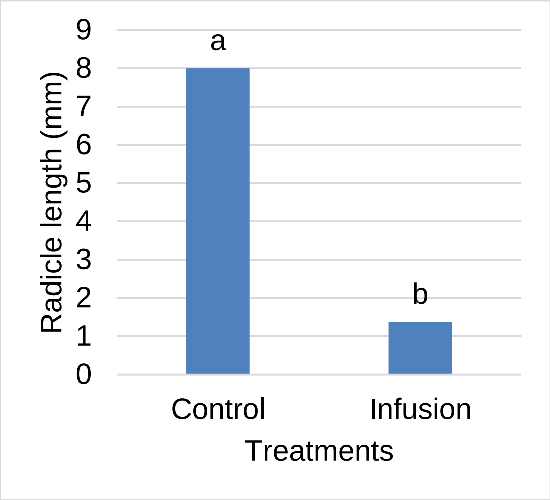


Figure 3.16: Mean comparison for the effect of infusions on the radicle length of *Eragrostis curvula*.

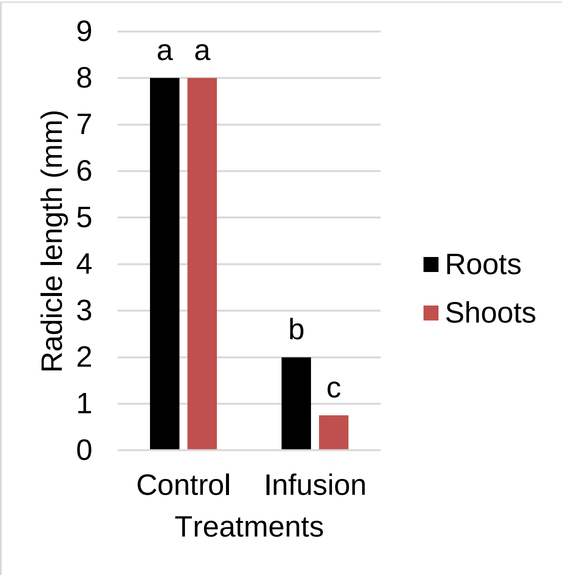


Figure 3.17: Mean comparison for the interaction between plant parts and infusions on the radicle length of *Eragrostis curvula*.

3.3.3 *Eragrostis tef*

3.3.3.1 Days to first germination

Differences in days to first germination were significant (P ≤ 0.05; Figure 3.18) between the interaction between infusions and plant parts (Annexure A - Table A3.1.2). All other treatments, including plant parts and season and infusions as main factors were not significant (P ≥ 0.05). Significant differences where the interaction between plant parts and infusions were concerned, was due to the roots infusion of which was significantly different from all other treatments (Annexure A - Table A3.1.5).

In the two control treatments that represented roots and shoots infusions collected in summer, *E. tef* started germinating on day 7, while it started germinating on day 8 in the two treatments that represented plant material collected in winter. *Eragrostis tef* started germinating on day 10, where roots and shoots infusions collected in summer were applied (Table 3.1). *Eragrostis tef* started germinating on day 13, where the roots infusion collected in winter was applied, but on day 12 where the shoots infusion collected in winter was applied (Table 3.1).

3.3.3.2 Days to maximum germination

There were no significant differences (P ≥ 0.05), including infusions, season and plant parts, as the main factor (Annexure A - Table A3.2.2). In the control treatments, *E. tef* reached maximum germination on day 14 in treatments that represented infusions from roots and shoots collected in summer and on day 17 in treatments that represented infusions from roots and shoots collected in winter. *Eragrostis tef* reached maximum germination on day 15 where the roots and shoots infusions collected in summer were applied (Table 3.1), but it reached maximum germination on day 16 where the roots and shoots infusions collected in winter were applied (Table 3.1).

3.3.3.3 Germination percentage

Differences in germination percentage were highly significant (P ≤ 0.01; Figure 3.19, Figure 3.20, Figure 3.21 and Figure 3.22) between infusions, the interaction between infusions and plant parts, the interaction between infusions and season and the interaction between infusions, plant parts and season (Annexure A - Table A3.3.2). All other factors were not significant ($P \geq 0.05$), including plant parts and season as the main factors. Infusions (18.19%), the interaction between infusions and plant parts (22.32%), the interaction between infusions and season (35.99%) and the interaction between infusions, plant parts and season (13.61%) comprised 90.11% of the total deviance. Significant differences occurred between the infusions (Annexure A - Table A3.3.3). However, where the interaction between plant parts and infusions were concerned, the roots infusion of the control treatments was significantly different from other treatments (Annexure A - Table A3.3.5). Where the interaction between infusions and season were concerned the summer infusion of the control treatments and of the infusion were significantly different from other treatments and also significantly different from each other (Annexure A - Table A3.3.8). Where the interaction between plant parts, infusions and season were concerned, the summer and winter infusion from the roots of the control treatments and summer infusion from the shoots of the control treatments, as well as the winter infusion from the shoot of infusion were significantly different from other treatments (Annexure A - Table A3.3.9).

In the control treatments, *E. tef* had a similar germination percentage, namely of 93%, in treatments that represented infusions of roots and shoots collected in summer and winter. In both seasons, treatments that involved roots infusions obtained 25% germination while treatments that involved shoots infusions obtained 18% (Annexure A - Table 3.1).

3.3.3.4 Radicle length

Differences in radicle length were significant ($P \leq 0.05$; Figure 3.23 - 3.25) between infusions, the interaction between infusions and plant parts and the interaction between infusions and season (Annexure A - Table A3.4.2). All other factors were not significant ($P \geq 0.05$), including plant parts and season as the main factors. Infusions (12.20%), the interaction between infusions and plant parts (20.24%) and the interaction between infusions and season (11.15%) comprised 43.59% of the total deviance. Significant differences occurred between the infusions (Annexure A - Table A3.4.3). However where the interaction between plant parts and infusions were concerned the roots infusion was significantly different from other treatments (Annexure A - Table A3.4.5). Where the interaction between infusions and season were concerned, the summer infusion was significantly different from other treatments (Annexure A - Table A3.4.7).

In the control treatments, *E. tef* reached a radicle length of 8 mm from the roots and shoots materials collected in summer. In both seasons, the roots infusion obtained a radicle length of 2 mm while the shoots infusion obtained a radicle length of 3 mm (Table 3.1).

The control treatments and the infusions had similar inhibitory effects on days to first germination and days to maximum germination, but the infusion had a bigger inhibitory effect on the germination percentage and radicle length compared to the control treatments.

Where plant parts were concerned, the shoots and roots infusions had similar inhibitory effects on days to first and maximum germination, as well as on the germination percentage and radicle length.

Where seasons were concerned, summer and winter infusions had similar inhibitory effects on days to first and maximum germination, as well as on the germination percentage and radicle length.

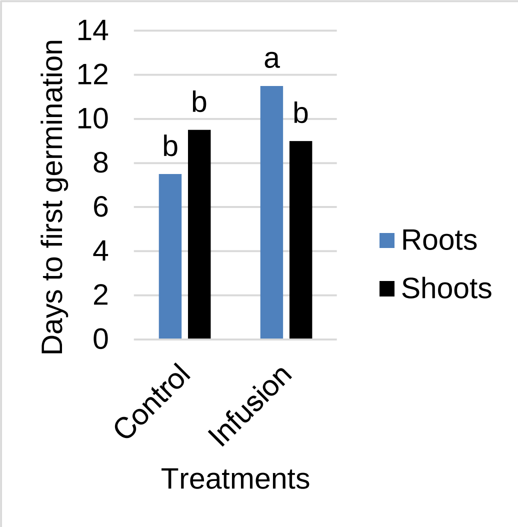


Figure 3.18: Mean comparison for the interaction between plant parts and infusions on days to first germination of *Eragrostis tef*.

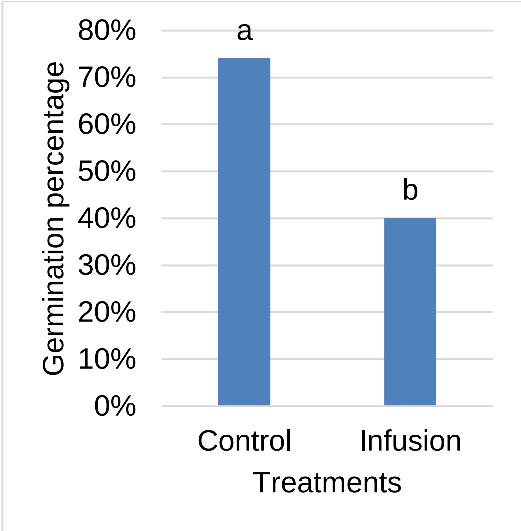


Figure 3.19: Mean comparison for the effect of infusions on the germination percentage of *Eragrostis tef*.

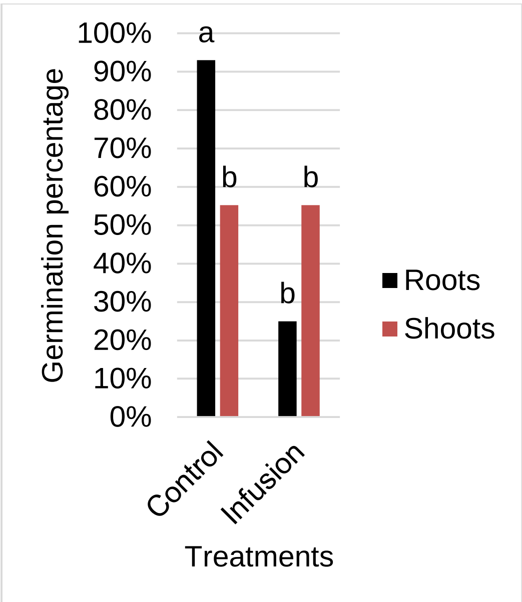


Figure 3.20: Mean comparison for the interaction between plant parts and infusions on the germination percentage of *Eragrostis tef*.

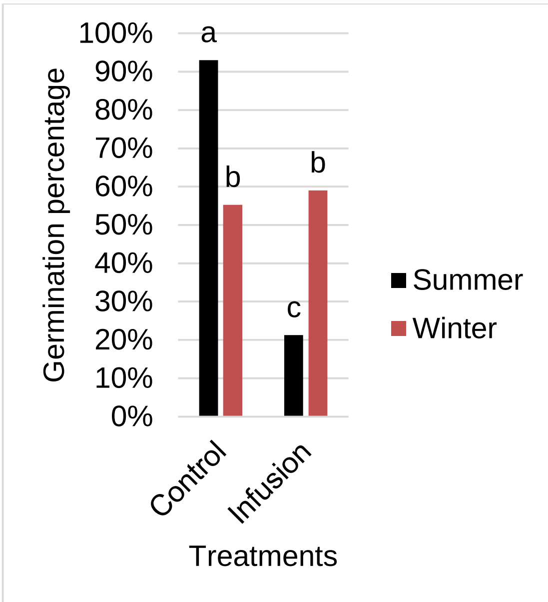


Figure 3.21: Mean comparison for the interaction between infusions and season on the germination percentage of *Eragrostis tef*.

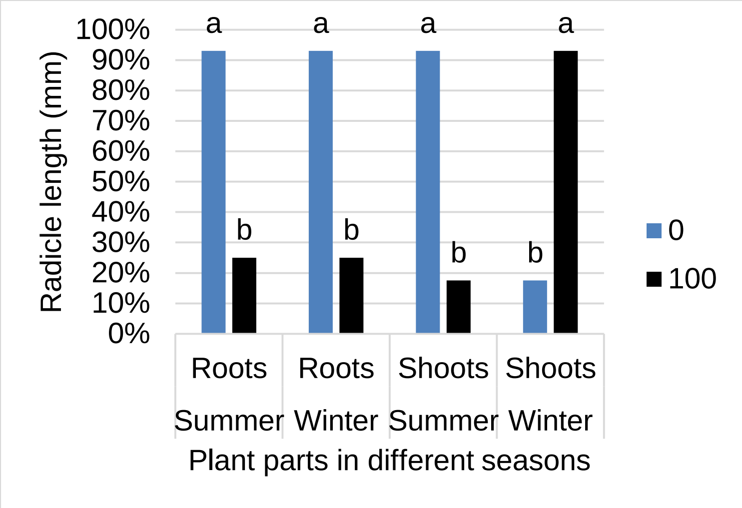


Figure 3.22: Mean comparison for the interaction between plant parts, infusions and season on the germination percentage of *Eragrostis tef*.

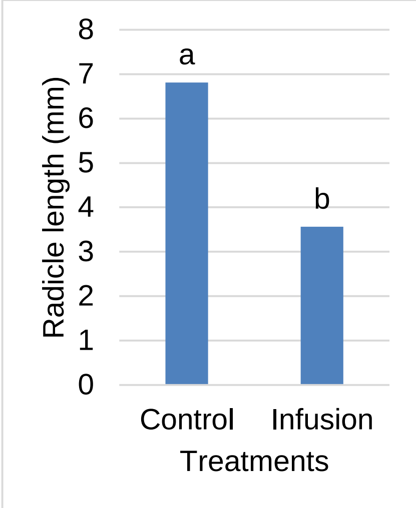


Figure 3.23: Mean comparison for the effect of infusions on the radicle length of *Eragrostis tef*.

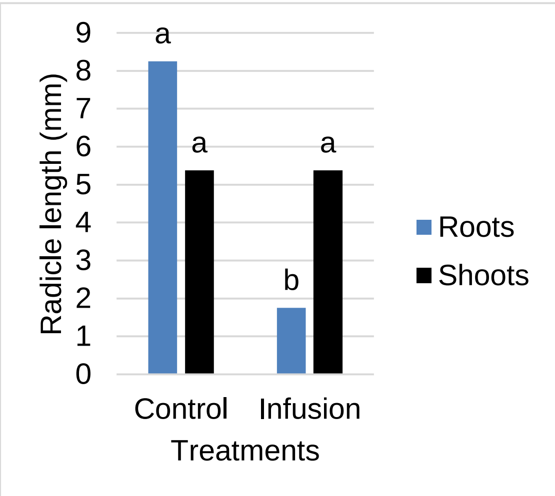


Figure 3.24: Mean comparison for the interaction between plant parts and infusions on the radicle length of *Eragrostis tef*.

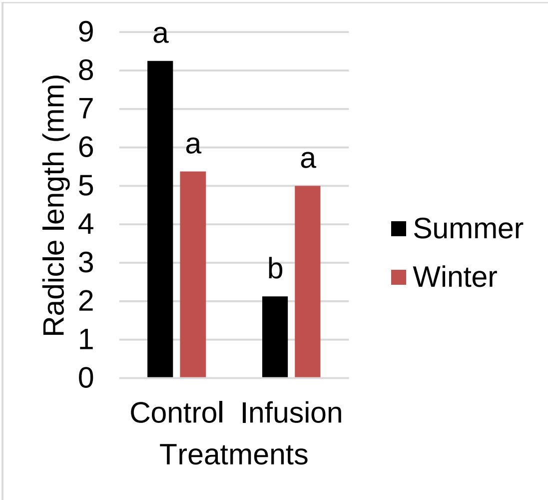


Figure 3.25: Mean comparison for the interaction between infusions and season on the radicle length of *Eragrostis tef*.

3.3.4 *Panicum maximum*

3.3.4.1 Days to first germination

There was no significant ($P \geq 0.05$) difference between treatments, including infusions, season and plant parts as the main factor (Annexure A - Table A4.1.2). In all the control treatments, *P. maximum* started germinating on day 10 in both treatments that represented infusions from roots and shoots collected in both summer and winter. *Panicum maximum* started germinating on day 13 with the roots infusion collected in both summer and winter, while it started germinating on day 10 with the shoots infusion collected in both summer and winter (Table 3.1).

3.3.4.2 Days to maximum germination

There was no significance ($P \geq 0.05$), including infusions, season and plant parts, as the main factor (Annexure A - Table A4.2.2). In all the control treatments, *P. maximum* reached maximum germination on day 14 with the roots and shoots infusions collected in summer, while it reached maximum germination on day 17 with the roots infusions collected in winter, but reached maximum germination on day 12 with the shoots collected in winter. *Panicum maximum* reached maximum germination on day 15 with the roots infusion, but it reached maximum germination on day 11 with the shoots infusion collected in summer (Table 3.1). *Panicum maximum* reached maximum germination on day 16 with the roots infusions collected in winter, and on day 17 with the shoots infusion collected in winter (Table 3.1).

3.3.4.3 Germination percentage

Differences in germination were highly significant ($P \leq 0.01$; Figure 3.26) between infusions (Annexure A - Table A4.3.2). All other factors were not significant ($P \geq 0.05$), including plant parts and season as the main factors. Infusions comprised 95.97% of the total deviance. Significant differences occurred between the infusions (Annexure A - Table A4.3.3).

In all the control treatments, *P. maximum* had a germination percentage of 93% with the roots and shoots infusion collected in summer, while it had a germination percentage of 92% with the roots and shoots infusion collected in winter. *Panicum maximum* had a germination percentage of 17% with the roots infusion, but had a germination percentage of 14% with the shoots infusion collected in both summer and winter (Table 3.1).

3.3.3.4 Radicle length

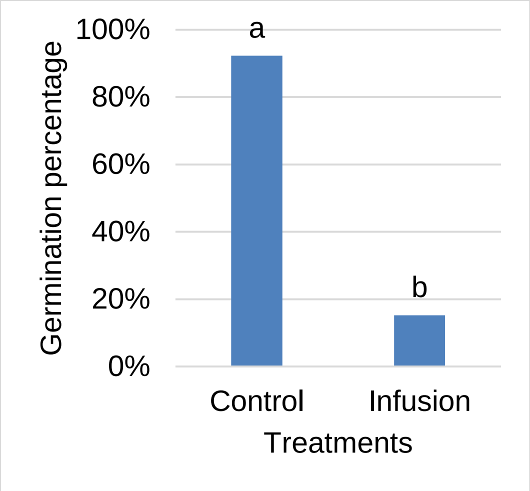
Differences in radicle length were highly significant ($P \leq 0.01$; Figure 3.27) between infusions (Annexure A - Table A4.4.2). All other factors were not significant ($P \geq 0.05$), including plant parts and season as the main factors. Infusions comprised 65.35% of the total deviance. A significant difference occurred between the infusions (Annexure A - Table A4.4.3).

In all the control treatments, *P. maximum* reached a radicle length of 7 mm with both the roots and shoots infusion collected in summer, while it reached a radicle length of 7 mm with the roots infusion collected in winter, but it reached a radicle length of 1 mm with the shoots infusion collected in winter. *Panicum maximum* reached a radicle length of 2 mm with the roots infusion collected in summer and winter, while reached a radicle length of 1 mm with the shoots infusion collected in summer, but it reached a radicle length of 7 mm with the shoots infusions collected in winter (Table 3.1).

The control treatments and the infusions had similar inhibitory effects on days to first and maximum germination, but the infusion had a bigger effect on the germination percentage and radicle length compared to the control treatments.

Where plant parts were concerned, the shoots and the roots infusions had similar inhibitory effects on days to first and maximum germination, as well as on the germination percentage and radicle length as compared to the control treatments.

Where seasons were concerned, summer and winter infusions had similar inhibitory effects on days to first and maximum germination, as well as on the germination percentage and radicle length.



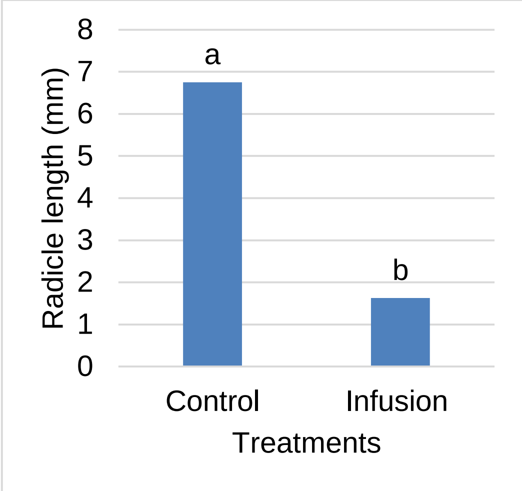


Figure 3.26: Mean comparison for infusions on germination percentage of *Panicum maximum*.

Figure 3.27: Mean comparison for infusions on radicle length of *Panicum maximum*.

3.4 Discussion

Overall, the infusion delayed days to first and maximum germination of *L. sativa*. The infusions had similar inhibitory effect on days to first and maximum germination of *E. curvula*, *E. tef* and *P. maximum.* Irrespective of whether the control treatments or the infusions were used on the three grass species, they started germinating and reached maximum germination more or less at the same time. The infusion led to a low germination percentage and short radicle length on all four species, compared to the control treatments, where no influence was observed. The results were similar to that of Ammann and Pieterse, (2005), who found that the original extract was the most effective in inhibiting seed germination in canola.

Where plant parts were concerned, whether roots or shoots infusions were used on all the four plant species, they started germinating and reached maximum germination more or less at the same time. The shoots infusion caused a lower germination percentage of *L. sativa* and *E. curvula* while the roots had no effect. This was in agreement with Snyman (2010), who found that different plant parts differed significantly in allelochemical potential and realized that it is important to evaluate the allelopathic potential of different plant parts of *S. plumosum*. Snyman (2010) also stated the fact that not only germination, but also early seedling development, are inhibited by *S. plumosum.*

The roots and shoots infusions had similar inhibitory effects on germination percentage of *E. tef* and *P. maximum*. Shoots infusion caused a short radicle length of *L. sativa* and *E. curvula* while the roots infusion had no effect. The roots and shoots infusions had similar inhibitory effects on radicle length of *E. tef* and *P. maximum*. The results supported the findings of Hansen-Quartey, Nyamapfene and Materechera (1998) which states that leaf extracts had a more pronounced adverse effect on the seed germination of selected test species than stem and root extracts.

Where seasons were concerned, whether infusions made from plant materials which were collected in summer or winter were used on all the four plant species, they started germinating and reached maximum germination more or less at the same time. Infusions made from plant material which were collected in summer caused a low germination percentage and short radicle length of *L. sativa*, but infusions made from plant materials which were collected in summer and winter had similar effect on the germination percentage and radicle length of *E. curvula*, *E. tef* and *P. maximum*.

3.5 Conclusions

To summarize, the infusions severely depressed the germination and radicle length of all four species, while the control treatment had no effect, which proved that plant parts had allelopathic effect on the germination of the receiver species.

The shoots infusion had a bigger effect on the germination and radicle length of all four species, while the roots infusion had a little effect, thus his showed that different plant parts have an allelopathic effect on the germination of the receiver species. In practice, it is recommended that the above ground biomass be removed from the side when controlling this species.

Infusions made from plant material collected in winter had a bigger effect on the germination and radicle length of all four species than infusions made from plant material collected in summer, which proved that there is a seasonal effect of allelopathy on the germination of the receiver plant species. The reason for the allelopathic effect to be more effective in winter is because during winter there is no rain and in summer the availability of rain leaches away these chemicals and lessons the allelopathic effect.

Table 3.1: Average germination and radicle length for plant parts, infusions and seasons.

Variables	Season	Infusion	*L. sativa*		*E. curvula*		*E. tef*		*P. maximum*	
			Roots	Shoots	Roots	Shoots	Roots	Shoots	Roots	Shoots
Days to first germination	Summer	Control	5	5	6	6	7	7	10	10
		Infusion	3	-	9	5	10	10	13	10
	Winter	Control	6	6	7	7	8	8	10	10
		Infusion	4	-	11	6	13	12	13	10
Days to maximum germination	Summer	Control	14	14	14	14	14	14	14	14
		Infusion	4	-	14	8	15	15	15	11
	Winter	Control	12	12	15	15	17	17	17	12
		Infusion	4	-	16	16	16	16	16	17
Germination percent	Summer	Control	94	94	84	84	93	93	93	93
		Infusion	1	1	14	4	25	18	17	14
	Winter	Control	94	94	80	84	93	93	92	14
		Infusion	-	1	14	4	25	18	17	92
Radicle length	Summer	Control	31	31	8	8	8	8	7	7
		Infusion	1	-	2	1	2	3	2	1
	Winter	Control	31	31	11	8	8	8	7	1
		Infusion	1	-	2	1	2	3	2	7

CHAPTER 4

THE EFFECT OF STORED ROOT AND SHOOT EXTRACTS OF *SERIPHIUM PLUMOSUM* AS AN ALLELOPATHIC AGENT

4.1 Introduction

Snyman (2008) found that both green and dead *S. plumosum* plants possesses allelopathic characteristics. Toxic substances accumulate in dry leaves during winter and leach into the soil during the summer rainfall period. This led to the conclusion that the allelopathic characteristic of *S. plumosum* are more severe if plant materials are not exposed to leaching for an extended time period (Snyman, 2008). This is in accordance with the results obtained in Chapter 3, where it was indicated that infusion of plant materials collected in winter had a bigger effect than those collected in summer. In this Chapter, this phenomenon is investigated further, together with the effects of plant materials that were not exposed to leaching.

4.2 Methodology

The experiment layout (2 X 2 X 2 factorial, in a randomized block design, replicated four times), collection of plant materials, determination of allelopathic effects and data collection and analysis followed the same procedure as in Chapter 3, the exception being that treatments also involved collected plant parts, which were stored for four months before the infusions were made. The experiment thus consisted of the following treatments:

- An infusion of fresh roots material collected in summer
- An infusion of stored roots material collected in summer
- An infusion of fresh roots material collected in winter
- An infusion of stored roots material collected in winter
- An infusion of fresh shoots material collected in summer
- An infusion of stored shoots material collected in summer
- An infusion of fresh shoots material collected in winter
- An infusion of stored shoots material collected in winter

4.3 Results

4.3.1 *Lactuca sativa*

4.3.1.1 Days to first germination

Days to first germination were significant ($P \leq 0.05$; Figure 4.1 - 4.4) between season, the interaction between plant parts and season, the interaction between stored plant material and season and the interaction between plant parts and stored plant material (Annexure B - Table B1.1.2). All other factors including the infusion of plant parts and stored plant material as main factor were not significant ($P \geq 0.05$). Season (9.74%), the interaction between plant parts and season (9.82%), the interaction between stored plant material and season (10.81%), and the interaction between plant part and stored plant material (12.25%) comprised 42.62% of the total deviance. Significant difference occurred between the seasons (Annexure B - Table B1.1.3). However, where interaction between the infusion of plant parts and season were concerned only the shoots material collected in winter were significantly different from others (Annexure B - Table B1.1.5). Where interaction between stored plant material and season were concerned, only the stored plant materials collected in summer were significantly different from others (Annexure B - Table B1.1.7). Where interaction between the plant parts and stored plant material were concerned, the fresh shoots material and stored roots material were significantly different from others (Annexure B - Table B1.1.8).

Lactuca sativa started germinating on day 3 where the infusion of the stored roots material collected in summer were applied, but started germinating on day 6 where stored shoots material collected in summer were applied (Table 4.1). Similarly, *L. sativa* started germinating on day 3 where the fresh roots material collected in summer were applied, but did not germinate where the fresh shoots material collected in summer was applied (Table 4.1).

Lactuca sativa started germinating on day 1 where the infusion of stored roots material collected in winter were applied, but did not germinate where the infusion of stored shoots material collected in winter were applied (Table 4.1). Similarly, *L. sativa* started germinating on day 4 where the infusion of fresh roots material collected in winter were applied, but did not germinate where the infusions of fresh shoots material collected in winter were applied (Table 4.1).

4.3.1.2 Days to maximum germination

Differences in days to maximum germination were significant ($P \leq 0.05$; Figure 4.5 and Figure 4.6) between the interaction between plant parts and season and the interaction between plant parts and stored plant material (Annexure B - Table B1.2.2). All other factors including plant parts, stored plant material and season as main factor were not significant ($P \geq 0.05$). The interaction between plant parts and season (13.23%) and the interaction between plant parts and stored plant material (9.94%) comprised 23.17% of the total deviance. Significant difference on the interaction between plant parts and season was due to the shoots material in winter which was significantly different from others (Annexure B - Table B1.2.7). Where interaction between stored plant material and plant parts were concerned only the fresh material from shoots was significantly different from others (Annexure B - Table B1.2.8).

Lactuca sativa reached maximum germination on day 5 where the infusion of stored roots material collected in summer were applied, but reached maximum germination on day 9, where the infusion of stored shoots material collected in summer were applied (Table 4.1). Similarly, *L. sativa* reached maximum germination on day 4, where the infusion of fresh roots material collected in summer was applied, but did not germinate where the fresh shoots material collected in summer was applied (Table 4.1).

Lactuca sativa reached maximum germination on day 3 where the infusions of stored roots material collected in winter were applied, but did not germinate where the infusion of stored shoots material collected in winter were applied (Table 4.1). Similarly, *L. sativa* reached maximum germination on day 4, where the fresh roots material collected in winter were applied, but did not germinate where the infusion of fresh shoots material collected in winter were applied (Table 4.1).

4.3.1.3 Germination percentage

Differences in germination percentage were highly significant (P ≤ 0.01; Figure 4.7, and Figure 4.8) between infusions of stored plant parts and season (Annexure B - Table B1.3.2). All other factors including plant parts as the main effect were not significant. Stored plant parts (29.50%) and season (24.54%) comprised 54.04% of the total deviance. Significant differences occurred between the infusions of stored plant parts (Annexure B - Table B1.3.3) and also between the seasons (Annexure B - Table B1.3.4).

Lactuca sativa had a germination percentage of 6% where the infusions of stored roots material collected in summer were applied, but reached maximum germination percentage of 8% where the infusions of stored shoots material collected in summer were applied (Table 4.1). Similarly, *L. sativa* had a germination percentage of 1% where the infusions of fresh roots material collected in summer were applied, but did not germinate where infusions of fresh shoots material collected in summer were applied (Table 4.1).

Lactuca sativa reached maximum germination percentage of 1% where the infusions of stored roots material collected in winter were applied, but did not germinate where the infusions of stored shoots material collected in winter were applied (Table 4.1). Similarly, *L. sativa* had a germination percentage of 1% where the infusions of fresh roots material collected in winter were applied, but did not germinate where the infusions of fresh shoots material collected in winter were applied (Table 4.1).

4.3.1.4 Radicle length

Differences in radicle length were highly significant (P ≤ 0.01; Figure 4.9) between infusions of infusions of stored plant materials (Annexure B - Table B1.4.2). Season as the main factor was significant (P ≤ 0.05; Figure 5.10). All other factors including plant parts as the main effect were not significant (P ≥ 0.05). Stored plant material (15.81%) and season (18.67%) comprised 34.48% of the total deviance. Significant difference occurred between the stored plant parts (Annexure B - Table B1.4.3) and also between the seasons (Annexure B - Table B1.4.4).

Lactuca sativa reached a radicle length of 3 mm where both the infusions of stored roots and shoots material collected in summer were applied (Table 4.1). Similarly, *L. sativa* reached a radicle length of 1 mm where the infusions of fresh roots material collected in summer was applied, but did not germinate where the infusions of fresh shoots material collected in summer were (Table 4.1).

Lactuca sativa reached a radicle length of 1 mm where the infusions of stored roots material collected in winter were applied, but did not germinate where the infusions of stored shoots material collected in winter were applied (Table 4.1). Similarly, *L. sativa* reached a radicle length of 1 mm where the infusions of fresh roots material collected in winter were applied, but did not germinate where the infusions of fresh shoots material collected in winter were applied (Table 4.1).

Where plant parts were concerned, the infusions of stored shoots and roots material had similar inhibitory effects on days to first and maximum germination, as well as on the germination percentage and radicle length.

Where seasons were concerned, the infusion of plant material collected in winter and stored had a bigger inhibitory effect on days to first germination, but the infusions of stored plant material collected in summer and winter had similar inhibitory effect on days to maximum germination, while the infusions of plant material collected in winter and stored had a bigger inhibitory effect on the germination percentage and radicle length.

Where stored plant material were concerned, the infusions of fresh and stored plant material had similar inhibitory effects on days to first and maximum germination, but the infusions of fresh material had a bigger inhibitory effect on the germination percentage and radicle length.

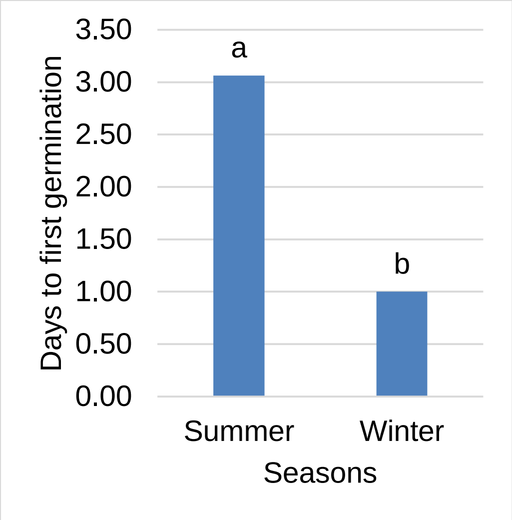


Figure 4.1: Mean comparison for the effect of season on days to first germination of *Lactuca sativa*.

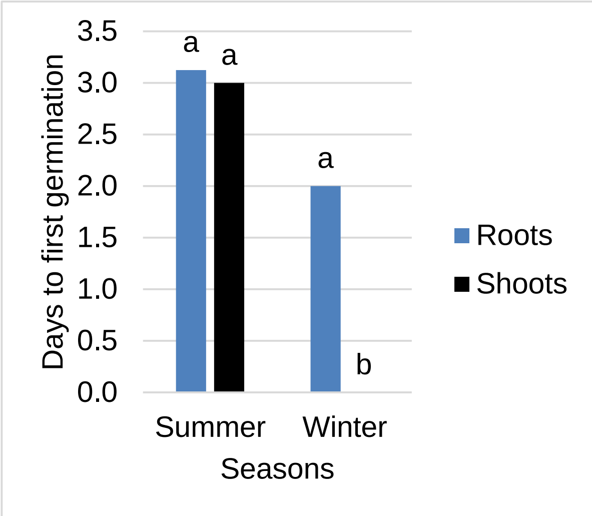


Figure 4.2: Mean comparison for the interaction between plant parts and season on days to first germination of *Lactuca sativa*.

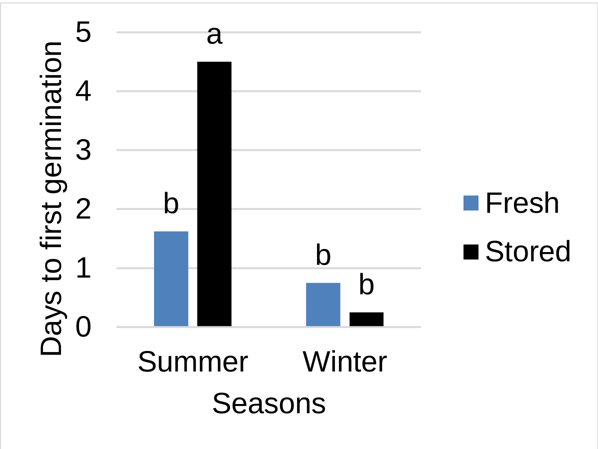


Figure 4.3: Mean comparison for the interaction between stored and season on days to first germination of *Lactuca sativa*.

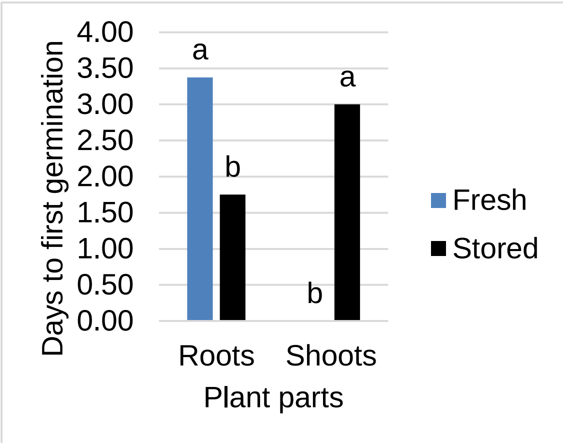


Figure 4.4: Mean comparison for the interaction between plant parts and stored on days to first germination of *Lactuca sativa*.

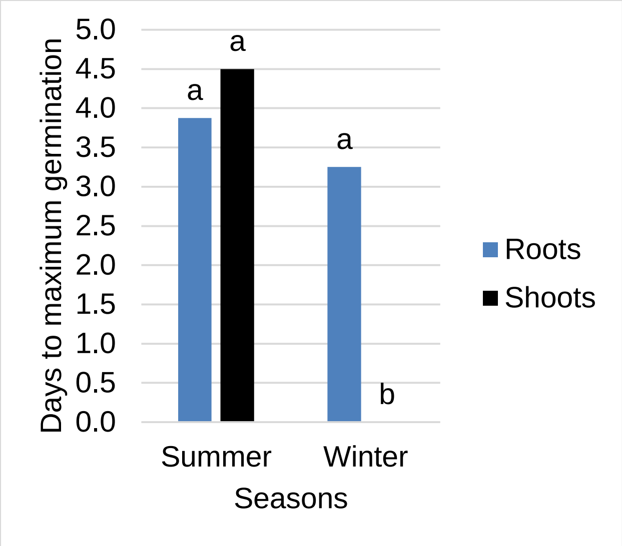


Figure 4.5: Mean comparison for the interaction between plant parts and season on days to maximum germination of *Lactuca sativa*.

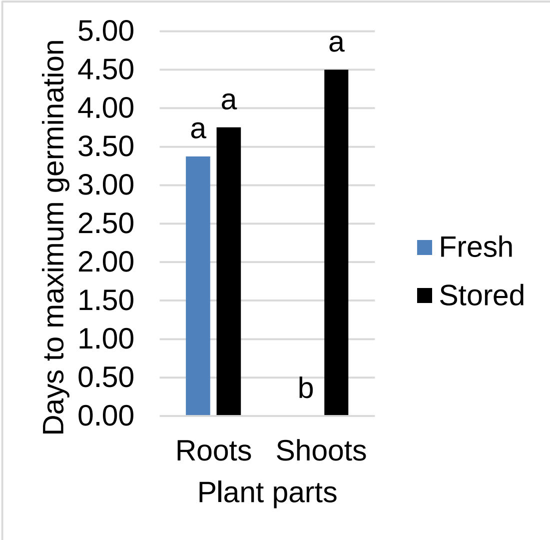


Figure 4.6: Mean comparison for the interaction between plant parts and stored on days to maximum germination of *Lactuca sativa*.

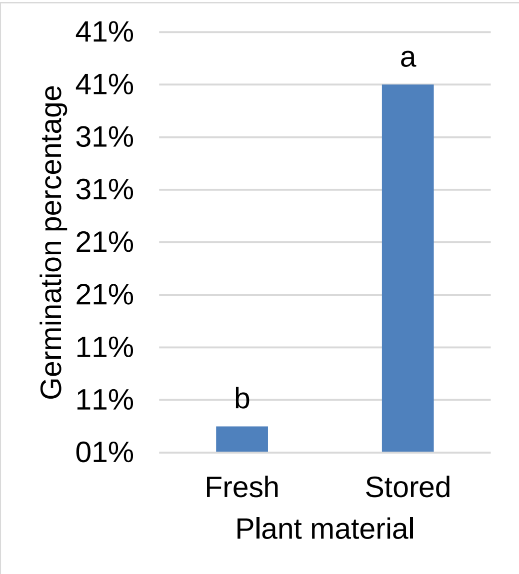


Figure 4.7: Mean comparison for the effect stored on the germination percentage of *Lactuca sativa*.

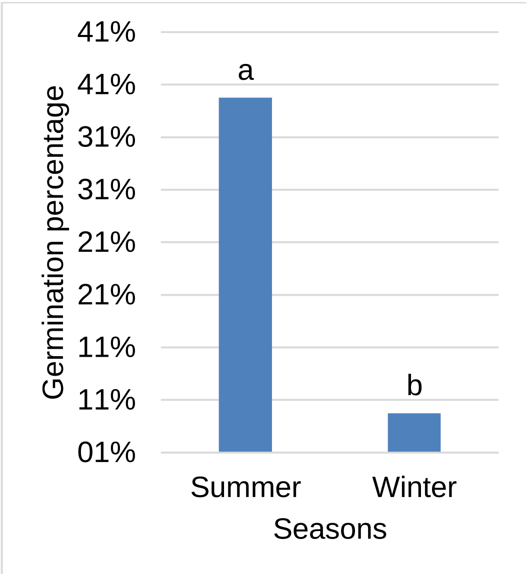


Figure 4.8: Mean comparison for the effect of season on the germination percentage of *Lactuca sativa*.

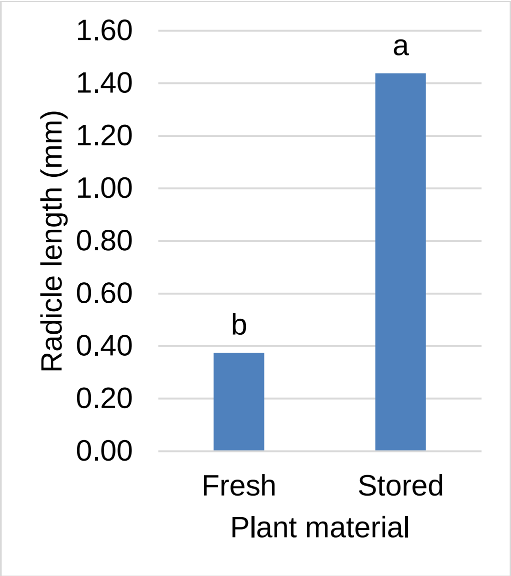


Figure 4.9: Mean comparison for the effect of stored on the radicle length of *Lactuca sativa*.

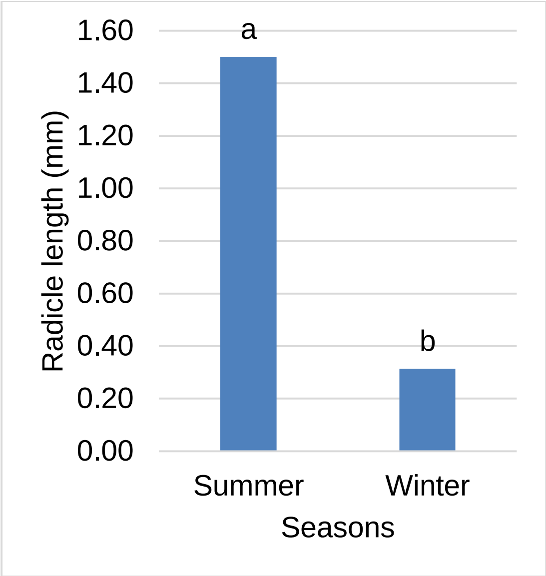


Figure 4.10: Mean comparison for the effect of season on the radicle length of *Lactuca sativa*.

4.3.2 *Eragrostis curvula*

4.3.2.1 Days to first germination

There was no significant difference between the treatments including plant parts and season and stored plant material as main factors (Annexure B - Table B2.1.2).

Eragrostis curvula started germinating on day 7 where both the infusions of roots and shoots material collected in summer and stored were applied (Table 4.1). Similarly, *E. curvula* started germinating on day 9 where the infusions of fresh roots material collected in summer and used immediately were applied, but started germinating on day 5 where the infusions of fresh shoots material collected in summer were applied (Table 4.1).

Eragrostis curvula started germinating on day 9 where both the infusions of stored roots and shoots material collected in winter were applied (Table 4.1). Similarly, *E. curvula* started germinating on day 11 where the infusions of fresh roots material collected in winter were applied, but started germinating on day 6 where the infusions of fresh shoots material collected in winter was applied (Table 4.1).

4.3.2.2 Days to maximum germination

Only the interaction between infusions of stored plant material and season were highly significant ($P \leq 0.01$; Figure 4.11) (Annexure B - Table B2.2.2). All other factors including plant parts, stored plant parts and season as main factor were not significant ($P \geq 0.05$). The interaction between stored plant material and season comprised 25.17% of the total deviance. Significant difference on the interaction between season and stored plant material was because of plant material which were collected in winter and stored and also plant materials which were collected in summer and used immediately were significantly different from others (Annexure B - Table B2.2.6).

Eragrostis curvula reached maximum germination on day 18 where the infusions of roots material collected in summer and stored were applied, but reached maximum germination on day 17, where the infusions of shoots material collected in summer and stored were applied (Table 4.1). Similarly, *E. curvula* reached maximum germination on day 14 where the infusions of fresh roots material collected in summer were applied, but reached maximum germination on day 8 where the infusions of fresh shoots material collected in summer were applied (Table 4.1).

Eragrostis curvula reached maximum germination on day 12 where the infusions of roots material collected in winter and stored were applied, but reached maximum germination on day 11 where the infusions of shoots material collected in winter and stored was applied (Table 4.1). Similarly, *E. curvula* reached maximum germination on day 16 where both the infusions of fresh roots and shoots material collected in winter were applied (Table 4.1).

4.3.2.3 Germination percentage

Stored plant material and plant parts were highly significant ($P \leq 0.01$; Figure 4.12, and Figure 4.13) (Annexure B - Table B2.3.2). All other factors including season as the main effect were not significant ($P \geq 0.05$). Stored plant material (15.49%) and plant parts (32.77%) comprised 48.26% of the total deviance. Significant difference occurred between the infusions of stored plant materials (Annexure B - Table B2.3.3) and also between the plant parts (Annexure B - Table B2.3.4).

Eragrostis curvula had a germination percentage of 18% where the infusions of roots material collected in summer and stored were applied, but had a germination percentage of 9% where the infusions of shoots material collected in summer and stored were applied (Table 4.1). Similarly, *E. curvula* had a germination percentage of 14% where the infusions of fresh roots material collected in summer were applied, but had a germination percentage of 4% where the infusions of fresh shoots material collected in summer were applied (Table 4.1).

Eragrostis curvula had a germination percentage of 32% where infusions of roots material collected in winter and stored were applied, but had a germination percentage of 12% where the infusions of shoots material collected in winter and stored were applied (Table 4.1). Similarly, *E. curvula* had a germination percentage of 14% where the infusions of fresh roots material collected in winter was applied, but had a germination percentage of 4% where the infusions of fresh shoots material collected in winter was applied (Table 4.1).

4.3.2.4 Radicle length

Stored plant material and plant parts were highly significant ($P \leq 0.01$; Figure 4.14 and Figure 4.15) (Annexure B - Table B2.4.2). All other factors including season as the main effect were not significant ($P \geq 0.05$). Stored plant material (18.89%) and plant parts (18.20%) comprised 37.09% of the total deviance. Significant difference occurred between the stored plant materials (Annexure B - Table B2.4.3) and also between the plant parts (Annexure B - Table B2.4.4).

Eragrostis curvula reached a radicle length of 4 mm where the infusions of roots material collected in summer and stored were applied, but reached a radicle length of 2 mm where the shoots material collected in summer and stored were applied (Table 4.1). Similarly, *E. curvula* reached a radicle length of 2 mm where the infusions of fresh roots material collected in summer were applied, but reached a radicle length of 1 mm where the infusions of fresh shoots material collected in summer were applied (Table 4.1).

Eragrostis curvula reached a radicle length of 2 where both the infusions of roots and shoots material collected in winter and stored were applied (Table 4.1). Similarly, *E.*

curvula reached a radicle length of 2 mm where the fresh roots material collected in winter were applied, but reached a radicle length of 1 mm where the fresh shoots material collected in winter were applied (Table 4.1).

Where plant parts were concerned, the infusions of stored shoots and roots material had similar inhibitory effects on days to first and maximum germination, but the infusions of stored shoots material had a bigger inhibitory effect on the germination percentage and radicle length.

Where seasons were concerned, the infusions of plant material collected in summer and winter and stored had similar inhibitory effects on days to first and maximum germination as well as on the germination percentage and radicle length.

Where stored plant material were concerned, the infusions of fresh and stored plant material had similar inhibitory effects on days to first and maximum germination, but the infusions of fresh material had a bigger inhibitory effect on the germination percentage and radicle length.

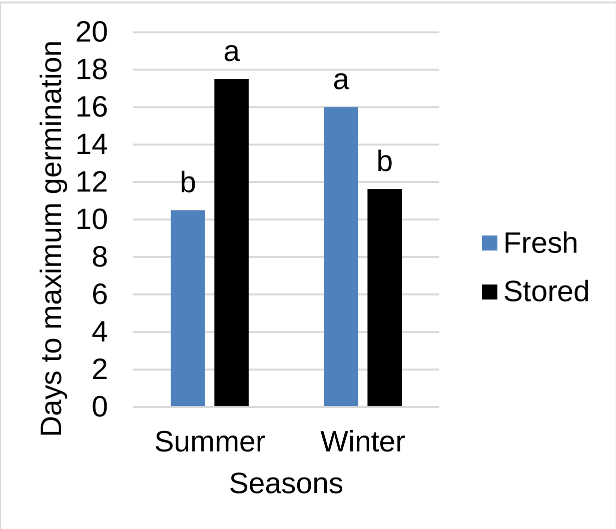


Figure 4.11: Mean comparison for the interaction between stored plant material and season on days to germination of *Eragrostis curvula*.

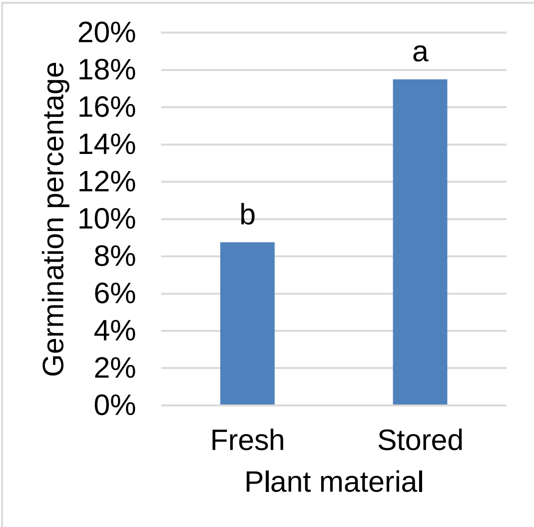


Figure 4.12: Mean comparison for the effect of stored plant material on the germination percentage of *Eragrostis curvula*.

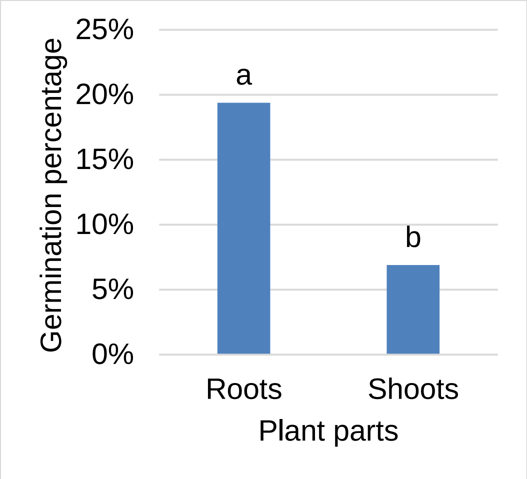


Figure 4.13: Mean comparison for the effect of plant parts on the germination percentage of *Eragrostis curvula*.

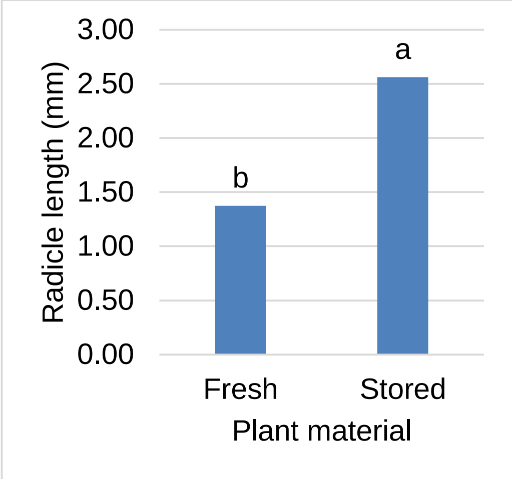


Figure 4.14: Mean comparison for the effect of stored plant material on the radicle length of *Eragrostis curvula*.

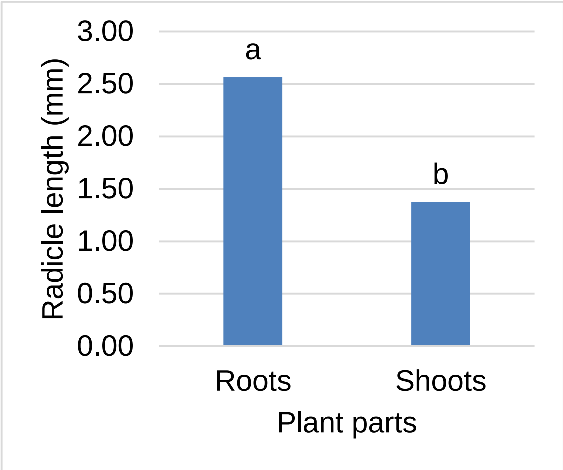


Figure 4.15: Mean comparison for the effect of plant parts on the radicle length of *Eragrostis curvula*.

4.3.3 *Eragrostis tef*

4.3.3.1 Days to first germination

Only stored plant materials were highly significant ($P \leq 0.01$; Figure 4.16) (Annexure B - Table B3.1.2). All other factors including season and plant parts as the main effects were not significant ($P \geq 0.05$). Significant difference occurred between the stored plant materials (Annexure B - Table B3.1.4).

Eragrostis tef started germinating on day 8 where both the infusions of roots and shoots material collected in summer and stored were applied (Table 4.1). Similarly, *E. tef* started germinating on day 10 where both the infusions of fresh roots and shoots material collected in summer were applied (Table 4.1).

Eragrostis tef started germinating on day 9 where both the infusions of stored roots and shoots material collected in winter were applied (Table 4.1). Similarly, *E. tef* started germinating on day 13 where the infusions of fresh roots material collected in winter was applied, but started germinating on day 12 where the infusions of fresh shoots material collected in winter was applied (Table 4.1).

4.3.3.2 Days to maximum germination

There was no significant ($P \geq 0.05$) difference where stored plant materials, season and plant parts as the main effects were concerned (Annexure B - Table B3.2.2).

Eragrostis tef reached maximum germination on day 18 where both the infusions of stored roots and shoots material collected in summer were applied (Table 4.1). Similarly, *E. tef* reached maximum germination on day 15 where both the infusions of fresh roots and shoots material collected in summer were applied (Table 4.1).

Eragrostis tef reached maximum germination on day 17 where both the infusions of stored roots and shoots material collected in winter were applied (Table 4.1). Similarly, *E. tef* reached maximum germination on day 16 where both the infusions of fresh roots and shoots material collected in winter were applied (Table 4.1).

4.3.3.3 Germination percentage

Only stored plant materials were highly significant ($P \leq 0.01$; Figure 4.17) (Annexure B - Table B3.3.2). Season and the interaction between stored and season were significant ($P \leq 0.05$; Figure 4.18, and Figure 4.19). All other factors including plant parts as the main effect were not significant ($P \geq 0.05$). Stored plant materials (16.94%), season (13.72%) and the interaction between stored plant material and season (10.33%) comprised 40.99% of the total deviance. Significant difference occurred between the stored plant materials and between seasons, however where interaction between season and stored plant materials were concerned only the stored materials in winter was significantly different from others (Annexure B - Table B3.3.5).

Eragrostis tef had a germination percentage of 25% where the infusions of stored roots material collected in summer were applied, but had a germination percentage of 21% where the infusions of stored shoots material collected in summer were applied (Table 4.1). Similarly, *E. tef* had a germination percentage of 25% where the infusions of fresh roots material collected in summer were applied, but had a germination percentage of 28% where the infusions of fresh shoots material collected in summer was applied (Table 4.1).

Eragrostis tef had a germination percentage of 55% where the infusion of stored roots material collected in winter were applied, but had a germination percentage of 39% where the infusions of stored shoots material collected in winter were applied (Table 4.1). Similarly, *E. tef* had a germination percentage of 25% where the infusion of fresh roots material collected in winter was applied, but had a germination percentage of 18% where the fresh shoots material collected in winter were applied (Table 4.1).

4.3.3.4 Radicle length

There was no significant ($P \geq 0.05$) difference between the treatments where stored plant material, season and plant parts as the main effects were concerned (Annexure B - Table B3.4.2).

Eragrostis tef reached a radicle length of 3 mm where both the infusions of stored roots and shoots material collected in summer were applied (Table 4.1). Similarly, *E. tef* reached a radicle length of 2 mm where the infusions of fresh roots material collected in summer were applied, but reached a radicle length of 3 mm where the infusions of fresh shoots material collected in summer were applied (Table 4.1).

Eragrostis tef reached a radicle length of 2 mm where both the infusions of stored roots and shoots material collected in winter were applied (Table 4.1). Similarly, *E. tef* reached a radicle length of 2 mm where the infusion of fresh roots material collected in winter were applied, but reached a radicle length of 3 mm where the infusion of fresh shoots material collected in winter were applied (Table 4.1).

Where plant parts were concerned, the infusions of stored shoots and roots material had similar inhibitory effects on days to first and maximum germination, as well as on the germination percentage and radicle length.

Where seasons were concerned, the infusions of stored summer and winter material had similar inhibitory effects on days to first and maximum germination, but the infusions of stored summer material had a bigger inhibitory effect on the germination percentage, while the infusions of stored summer and winter material had similar inhibitory effects on the radicle length.

Where stored plant materials were concerned, the infusions of stored plant material had a bigger inhibitory effect on days to first germination, but the infusions of fresh and stored plant material had similar inhibitory effects on days to maximum germination while the infusions of fresh material had a bigger inhibitory effect on the germination percentage. The infusions of fresh and stored plant material had similar inhibitory effects on the radicle length.

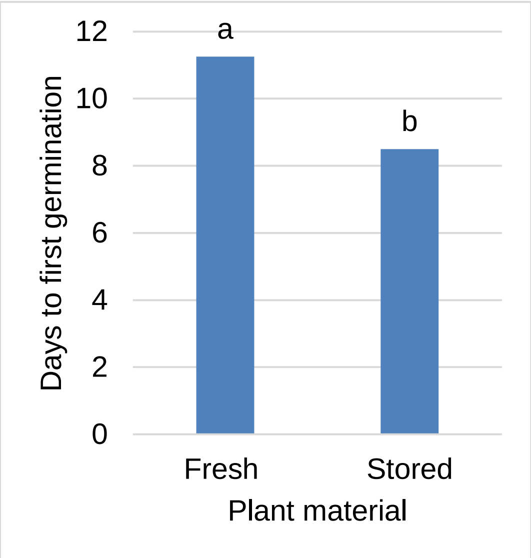


Figure 4.16: Mean comparison for the effect of stored plant material on days to first germination of *Eragrostis tef*.

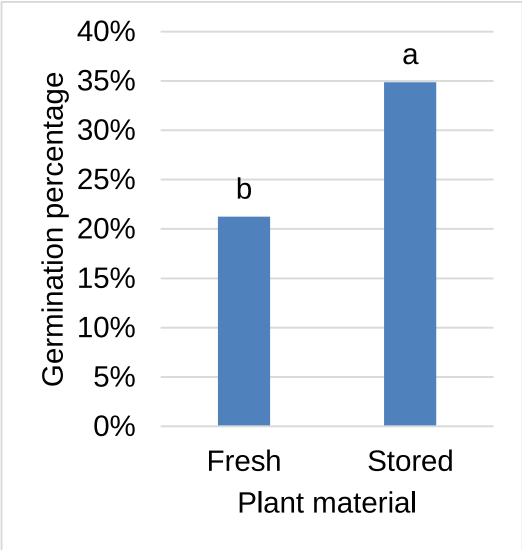


Figure 4.17: Mean comparison for the effect of stored plant material on the germination percentage of *Eragrostis tef*.

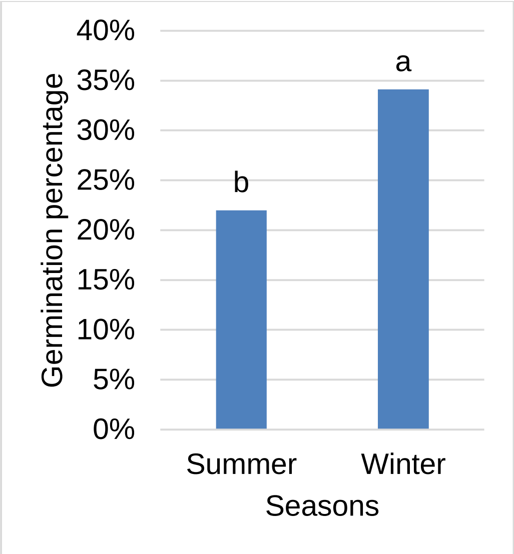


Figure 4.18: Mean comparison for the effect of seasons on the germination percentage of *Eragrostis tef*.

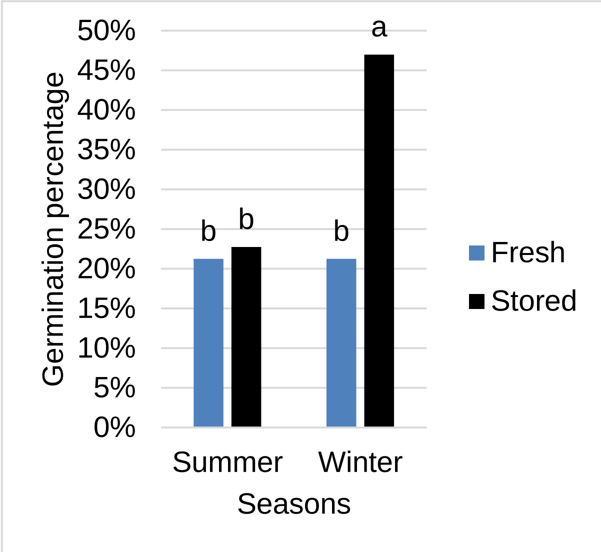


Figure 4.19: Mean comparison for the interaction between stored plant material and season on the germination percentage of *Eragrostis tef*.

4.3.4 *Panicum maximum*

4.3.4.1 Days to first germination

There was no significant (P ≥ 0.05) difference where stored plant material, season and plant parts as the main effects were concerned (Annexure B - Table B4.1.2).

Panicum maximum started germinating on day 11 where both the infusions of stored roots and shoots materials collected in summer were applied (Table 4.1). Similarly, *P. maximum* started germinating on day 13 where the infusions of fresh roots material collected in summer were applied, but started germinating on day 10 where the infusions of fresh shoots material collected in summer were applied (Table 4.1).

Panicum maximum started germinating on day 12 where both the infusions of stored roots and shoots material collected in winter were applied (Table 4.1). Similarly, *P. maximum* started germinating on day 13 where the infusion of fresh roots material collected in winter were applied, but started germinating on day 10 where the infusion of fresh shoots material collected in winter were applied (Table 4.1).

4.3.4.2 Days to maximum germination

There was no significant ($P \geq 0.05$) difference where stored plant material, season and plant parts as the main effects were concerned (Annexure B - Table B4.2.2). *Panicum maximum* reached maximum germination on day 18 where the infusions of stored roots material collected in summer were applied, but reached maximum germination on day 16 where the infusions of shoots collected in summer were applied (Table 4.1). Similarly, *P. maximum* reached maximum germination on day 15 where the infusions of fresh roots material collected in summer were applied, but reached maximum germination on day 11 where the infusions of fresh shoots material collected in summer were applied (Table 4.1).

Panicum maximum reached maximum germination on day 17 where both the infusions of stored roots and shoots material collected in winter were applied (Table 4.1). Similarly, *P. maximum* reached maximum germination on day 16 where the infusions of fresh roots material collected in winter were applied, but reached maximum germination on day 17 where the infusions of fresh shoots material collected in winter were applied (Table 4.1).

4.3.4.3 Germination percentage

Only infusions of stored plant material was highly significant ($P \leq 0.01$; Figure 4.20) (Annexure B - Table B4.3.2). Season was significant ($P \leq 0.05$; Figure 4.21). All other factors including the infusions of plant parts as the main effect were not significant ($P \geq 0.05$). Stored plant material (19.43%) and season (13.24%) comprised 32.67% of the total deviance. Significant difference occurred between the stored plant material and between seasons.

Panicum maximum had a germination percentage of 19% where the infusions of stored roots material collected in summer were applied, but had a germination percentage of 15% where the infusions of shoots collected in summer were applied (Table 5.1). Similarly, *P. maximum* had a germination percentage of 17% where the infusions of fresh roots material collected in summer were applied, but had a germination percentage of 14% where the infusions of fresh shoots material collected in summer were applied (Table 4.1).

Panicum maximum had a germination percentage of 36% where the stored roots material collected in winter were applied, but had a germination percentage of 31% where the stored shoots material collected in winter were applied (Table 4.1). Similarly, *P. maximum* had a germination percentage of 17% where the fresh roots material collected in winter were applied, but had a germination percentage of 14% where the infusions of fresh shoots material collected in winter were applied (Table 4.1).

4.3.4.4 Radicle length

There was no significant ($P \geq 0.05$) difference where the infusions of stored plant material, season and plant parts as the main effects were concerned (Annexure B - Table B4.4.2).

Panicum maximum reached a radicle length of 4 mm where the infusions of stored roots material collected in summer were applied, but reached a radicle length of 2 mm where the infusions of shoots collected in summer were applied (Table 4.1). Similarly, *P. maximum* reached a radicle length of 2 mm where the infusions of fresh roots material collected in summer were applied, but reached a radicle length of 1 mm where the infusions of fresh shoots material collected in summer were applied (Table 4.1).

Panicum maximum reached a radicle length of 2 mm where both the infusions of stored roots and shoots material collected in winter were applied (Table 4.1). Similarly, *P. maximum* reached a radicle length of 2 mm where the infusions of fresh roots material collected in winter were applied, but reached a radicle length of 7 mm where the infusions of fresh shoots material collected in winter were applied (Table 4.1).

Where plant parts were concerned, the infusions of stored shoots and roots material had similar inhibitory effects on days to first and maximum germination, as well as on the germination percentage and radicle length.

Where seasons were concerned, the infusions of stored summer and winter material had similar inhibitory effects on days to first and maximum germination, but the infusions of stored summer material had a bigger inhibitory effect on maximum germination percentage while the infusions of stored summer and winter material had similar inhibitory effects on the radicle length.

Where stored plant material were concerned, the infusions of fresh and stored plant material had similar inhibitory effects on days to first and maximum germination, but the infusions of fresh material had a bigger inhibitory effect on the germination percentage while the infusions of fresh and stored plant material had similar inhibitory effects on the radicle length.

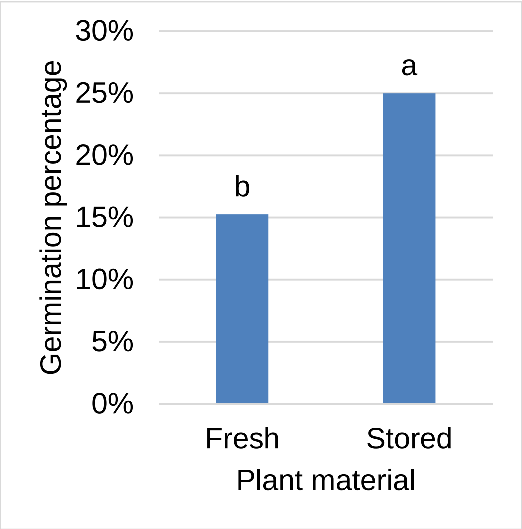


Figure 4.20: Mean comparison for the effect of stored plant material on the germination percentage of *Panicum maximum*.

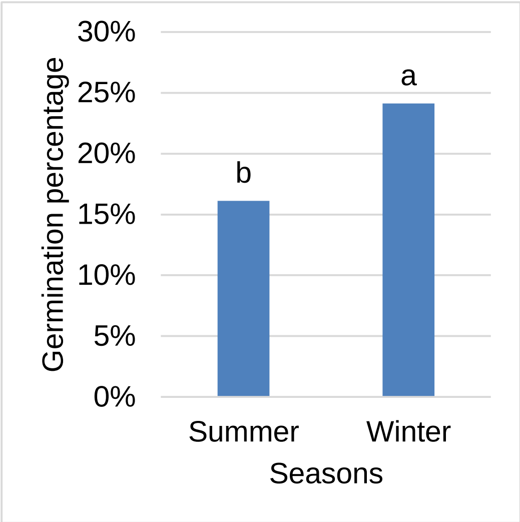


Figure 4.21: Mean comparison for the effect of seasons on the germination percentage of *Panicum maximum*.

Table 4.1: Average germination and radicle length for plant parts, stored plant material and seasons.

Variables	Season	Infusion	*L. sativa*		*E. curvula*		*E. tef*		*P. maximum*	
			Roots	Shoots	Roots	Shoots	Roots	Shoots	Roots	Shoots
Days to first germination	Summer	Stored	3	6	7	7	8	8	11	11
		Fresh	3	-	9	5	10	10	13	10
	Winter	Stored	1	-	9	9	9	9	12	12
		Fresh	4	-	11	6	13	12	13	10
Days to maximum germination	Summer	Stored	5	9	18	17	18	18	18	16
		Fresh	4	-	14	8	15	15	15	11
	Winter	Stored	3	-	12	11	17	17	17	17
		Fresh	4	-	16	16	16	16	16	17
Germination percent	Summer	Stored	6	8	18	9	25	21	19	15
		Fresh	1	-	14	4	25	18	17	14
	Winter	Stored	1	-	32	12	55	39	36	31
		Fresh	1	-	14	4	25	18	17	14
Radicle length	Summer	Stored	3	3	4	2	3	3	4	2
		Fresh	1	-	2	1	2	3	2	1
	Winter	Stored	1	-	2	2	2	2	2	2
		Fresh	1	-	2	1	2	3	2	7

4.4 Discussion

Where plant parts were concerned, the infusions of stored roots and shoots material had similar inhibitory effects on days to first and maximum germination of all the receiver species. Whether the infusions of stored roots or shoots material were used on all the four plant species, they started germinating and reached maximum germination more or less at the same time. The infusions of stored shoots material caused a low germination percentage of *E. curvula*, compared to the infusions of stored roots material. The infusions of stored roots and shoots material had similar inhibitory effects on the germination percentage of *L. sativa, E. tef* and *P. maximum*. The infusions of stored shoots material caused a short radicle length of *E. curvula*, compared to the infusions of stored roots infusion. However, the infusions of stored roots and shoots material had similar inhibitory effects on the radicle length of *L. sativa, E. tef* and *P. maximum*.

Where seasons were concerned, the infusions of stored summer and winter material had the same effect with days to first germination of *E. curvula*, *E. tef* and *P. maximum*. Whether the infusions of stored summer or winter material were used on all the three plant species, they started germinating more or less at the same time. However, the infusions of stored winter material delayed days to first germination of *L. sativa*. The infusions of stored summer and winter material had similar inhibitory effects on days to maximum germination all the receiver species. Whether the infusions of stored summer or winter material were used on all the four plant species, they reached maximum germination more or less at the same time. The infusions of stored winter material caused a low germination percentage of *L. sativa*, but the infusions of stored summer material resulted in low germination percentage of *E. tef* and *P. maximum*. However, the infusions of stored summer and winter material had similar inhibitory effects on the germination percentage of *E. curvula*. The infusions of stored summer and winter material had similar inhibitory effects on the radicle length of *E. curvula*, *E. tef* and *P. maximum*. The infusions of stored winter material resulted in a short radicle length on *L. sativa*.

Where stored plant material was concerned, the infusions of fresh and stored plant material delayed days to first and maximum germination of *L. sativa*, *E. curvula*, and *P. maximum*. However, the infusions of stored plant material delayed days to first germination on *E. tef* while the infusions of fresh and stored plant material delayed days to maximum germination on *E. tef*. Whether fresh or stored material were used on *L. sativa E. curvula*, and *P. maximum*, they started germinating and reached maximum germination more or less at the same time. The infusions of fresh material resulted in a low germination percentage and short radicle length of *L. sativa* and *E. curvula*. However, the infusions of fresh material resulted in a low germination percentage of *E. tef* and *P. maximum* while the infusions of fresh and stored plant material resulted in short radicle length of *E. tef* and *P. maximum*. This was in agreement with Snyman (2010), who found that the germination of *L. sativa* was suppressed by extracts prepared from fresh plant material of *S. plumosum*. This was also in contrast with Snyman (2010), who found that *E. curvula* responded similarly to extracts from fresh and dry material.

4.5 Conclusions

To summarize, the stored shoots infusion had a bigger effect on the germination and radicle length of *E. curvula*, while both the stored shoots and roots infusions had a similar effect on the other three species. In practice, the shoots infusion have a bigger effect as in chapter 3 and from this chapter it clearly indicate the need to remove the shoot material from the side when controlling it as it proved that the species remain allelopathic even when stored for four months or more.

Infusions made from plant material collected in winter and stored had a bigger effect on the germination and radicle length of *L. sativa*, while the infusions made from plant material collected in summer and stored caused a low germination percentage of *E. tef* and *P. maximum*. Both infusions made from plant material collected and stored in both winter and summer suppressed the germination and radicle length of *E. curvula*. The reason for the allelopathic effect to be more effective in winter is the same as in chapter 3 whereby shortage of rain in winter led to the accumulation of this allelochemicals.

CHAPTER 5
ALLELOPATHIC EFFECT OF SOIL COLLECTED IN THE VICINITY OF *SERIPHIUM PLUMOSUM* ON FOUR TEST SPECIES

5.1 Introduction

Allelopathic chemicals or allelochemicals, derived from roots and plant leachates can persist in soil, affecting both neighbouring plants as well as those planted in succession. It has been hypothesised that allelopathic plants, in addition to qualitative and quantitative changes in the soil content/properties of allelochemicals, also might cause changes in soil chemical characteristics (Inderjit, 1998). Phenolic compounds have been reported to play a major allelochemical role in wide range of plant species. They can be released into soils as root exudates, leaf leachates and products of plant tissue decomposition (Kuiters and Sarink, 1986; Seal *et al*., 2004; Belz, 2007; Macı´as *et al*., 2007).

Seriphium plumosum seeds could survive in the soil for a number of years and remain viable, thus enabling re-establishment of the plant species after a certain period of time. This phenomenon is due to toxic substances from the leaves of the shrub that accumulated during the drier winter period and was washed into the soil during the summer rainfall period which inhibits the germination of other plant species (Snyman, 2010).

Apart from the direct toxic effect on other plants, some allelochemicals can also influence the availability of nutrients in the soil. The closest seedlings are found between 300 mm and 460 mm from the stem of the parent plant. This ensured the even distribution of *S. plumosum* plants over the area in time, and reduces establishment around the mother plants only, thus ensuring optimal use of limited soil-water (Snyman, 2010). The allelopathic characteristic in the soil takes 12 – 16 weeks to be lifted (Snyman, 2008). Both green plants and dead plants have this characteristic, the latter to a lesser extent (Snyman, 2008). Thus the objective of this study was to determine the effect of soil collected in the vicinity of *S. plumosum* on four test species.

5.2 Methodology

5.2.1 Study area

Soil samples were randomly collected at an infested site (Infested soil) and also from an area which is not infested (Non-infested soil) by *S. plumosum* during summer and winter months of 2014 at the Mabula Private Game Reserve.

5.2.2 Determining allelopathic effects

This study was conducted in a net house (30% shade cloth) at the University of Limpopo (23º53′10″S, 29º44′15″E).

The influence of the possible allelopathic effect of *S. plumosum* was tested on the same species used in Chapter 3 and Chapter 4. The experimental layout was similar to the one used in Chapter 3 and Chapter 4. The experiment thus consisted of the following treatments:

- Non-infested soil collected in summer (control treatment)
- Infested soil collected in summer
- Non-infested soil collected in winter (control treatment)
- Infested soil collected in winter
- Non-infested soil collected and stored in summer (control treatment)
- Infested soil collected and stored collected in summer
- Non-infested soil collected and stored in winter (control treatment)
- Infested soil collected and stored collected in winter

Both soils from infested and non-infested areas were sieved and placed in seed trays. Forty seeds of each of the receiver species were planted in seed trays, filled with soil collected from each site and germinated for a period of seven to 21 days in a net house. Soil which was collected from an area which was not infested by *S. plumosum* was used as a control. The data was collected, similar to Chapter 3 and Chapter 4.

5.2.3 Data analysis

Generalized linear model (GLM) analysis was applied to the number of days to first germination and to the number of days to maximum germination with the Poisson distribution (for counts) and logarithmic link function, testing for differences between the effects of two soils, two seasons and stored, as well as all their interactions.

Germination percentage data was analysed in the same way with GLM, but with the Binomial distribution (for proportions) and the logit link function, testing for differences between the effects of two soils, two seasons and stored, as well as all their interactions.

The radicle lengths were positively skewed and therefore analysed with GLM and the Gamma distribution, testing for differences between the effects of two soils, two seasons and stored soils, as well as all their interactions.

All predictions were compared with Fisher's protected least significant test at the 5% level ($P \leq 0.05$). Data were analysed using the statistical program GenStat® (Payne, 2014).

5.3 Results

Please note that only factors that were significant are illustrated graphically.

5.3.1 *Lactuca sativa*

5.3.1.1 Days to first germination

Days to first germination were not significant ($P \geq 0.05$) (Annexure C - Table C1.1.2). *Lactuca sativa* started germinating on day 7 in all the control treatments that represented non-infested soils collected in summer and winter. *Lactuca sativa* started germinating on day 7 where infested soils collected in summer were used, but started germinating on day 6 where infested soils collected in winter were used (Table 5.1).

5.3.1.2 Days to maximum germination

Differences in days to maximum germination were not significant ($P \geq 0.05$) (Annexure C - Table C1.2.2). *Lactuca sativa* reached maximum germination on day 17 in treatments that represented non-infested soils which were collected and used immediately in summer and winter, but it reached maximum germination on day 16 in stored non-infested soils collected and used immediately in winter. It reached maximum germination on day 19 where the infested soils collected in summer were used (Table 5.1), but reached maximum germination on day 12 where the infested soils collected and used immediately in winter were used, while it reached maximum germination on day 17 where the infested soils collected in winter and stored were used.

5.3.1.3 Germination percentage

Differences in germination percentage were highly significant ($P \leq 0.01$; Figure 5.1 - 5.5) between infested soils, seasons, stored soils and the interaction between stored soils and season as well as the interaction between infested soils and stored soils (Annexure C - Table C1.3.2). The interaction between infested soils and stored soils and season was significant ($P \leq 0.05$; Figure 5.6). The interaction between infested soils and season was not significant ($P \geq 0.05$). Infested soils (11.63%), seasons (8.51%), stored soils (15.03%) and the interaction between stored soils and season (20.22%), and the interaction between infested soils and stored soils (9.57%), as well as the interaction between infested soils and stored soils and season (5.82%) comprised 70.78% of the total deviance. Significant differences occurred between the between infested soils, seasons, stored soils. However, where the interaction between stored soils and season were concerned, winter immediately was significantly different from other treatments. Where the interaction between infested soils and stored soils were concerned, non-infested soils stored soils soil was significantly different from other treatments. Where the interaction between infested soils and stored soils and season were concerned, winter non-infested soils was significantly different to all other treatments, except for winter infested soils soil and winter non-infested soils soil was significantly different from all infested soils.

Lactuca sativa had a germination percentage of 87% in the non-infested soils collected and used immediately in summer and 41% in the non-infested soils collected and used immediately in winter, while it had a germination percentage of 98% in the non-infested soils collected in winter and stored (Table 6.1). *Lactuca sativa* had a germination percentage of 72% in the infested soils collected and used immediately in summer, but had a germination percentage of 63% in the infested soils collected in winter and stored. It had a germination percentage of 48% in infested soils collected and used immediately in winter, but had a germination percentage of 69% in infested soils collected in winter and stored (Table 5.1).

5.3.1.4 Radicle length

Differences in radicle length were highly significant ($P \leq 0.01$; Figure 5.7 and Figure 5.8) between infested soils and the interaction between stored soils and seasons (Annexure C - Table C1.4.2). All other factors were not significant ($P \geq 0.05$). Infested soils (51.95%) and the interaction between stored soils and season (16.65%) comprised 68.6% of the total deviance. Significant differences occurred between the infested soils. However, where the interaction between stored soils and season were concerned, winter immediately soils were significantly different from other treatments.

In all the control treatments, *L. sativa* reached a radicle length of 27 mm in non-infested soils collected and used immediately in summer and also in non-infested soils collected in winter and stored, but reached a radicle length of 3 mm from non-infested soils collected and used immediately in winter (Table 5.1). It reached a radicle length of 3 mm in infested soils collected and used immediately in summer, but reached a radicle length of 4 mm in infested soils collected and used immediately in winter while it reached 5 mm in infested soils in winter collected and stored (Table 5.1).

Where infested soils were concerned, infested soils and non-infested soils had similar inhibitory effects on days to first and maximum germination, but infested soils had a bigger effect on the germination percentage and radicle length.

Where stored soils were concerned, fresh and stored soils had similar inhibitory effects on days to first and maximum germination as well as on the radicle length, but the stored soils had a bigger inhibitory effects on the germination percentage.

Where seasons were concerned, summer and winter collected soils had similar inhibitory effects on days to first and maximum germination as well as on the radicle length, but winter material had a bigger inhibitory effect on the germination percentage.

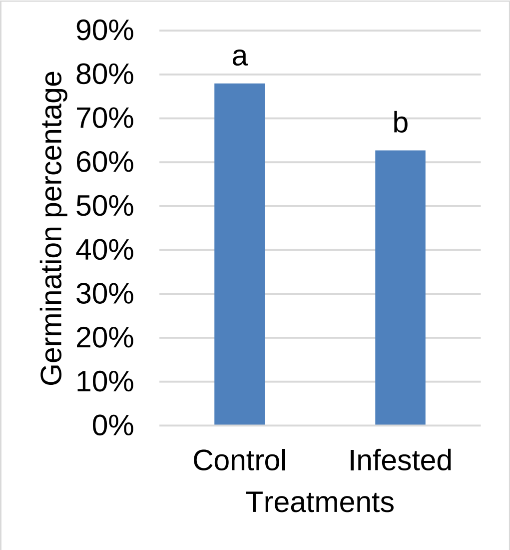


Figure 5.1: Mean comparison for the effect of infested soils on the germination percentage of *Lactuca sativa*.

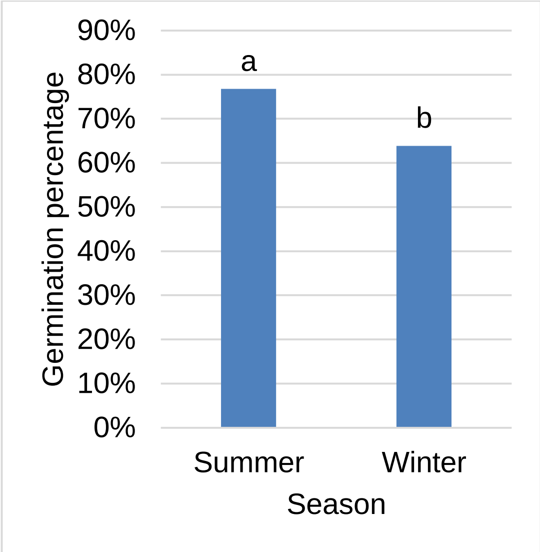
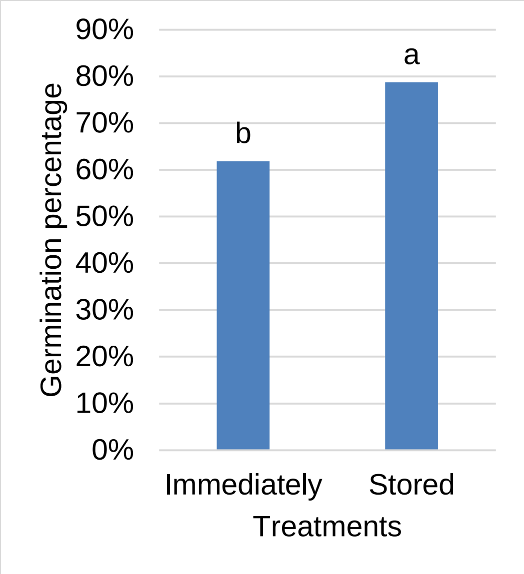


Figure 5.2: Mean comparison for the effect of season of soil collection on the germination percentage of *Lactuca sativa*.



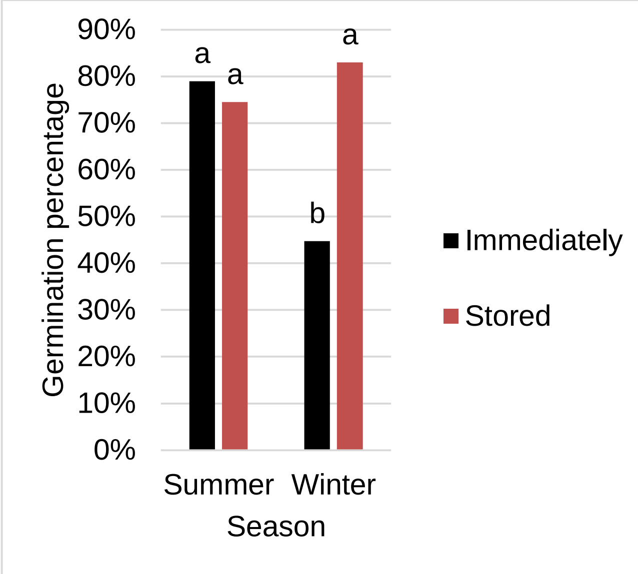
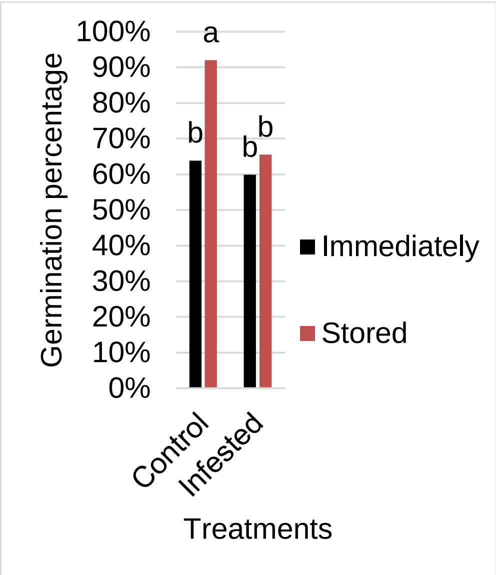


Figure 5.3: Mean comparison for the effect of stored soils on the germination percentage of *Lactuca sativa*.

Figure 5.4: Mean comparison for the interaction between stored soils and season of soil collection on the germination percentage of *Lactuca sativa*.



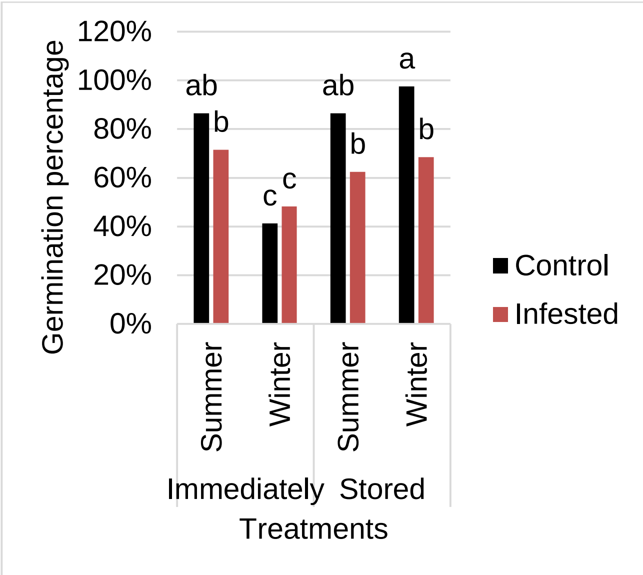
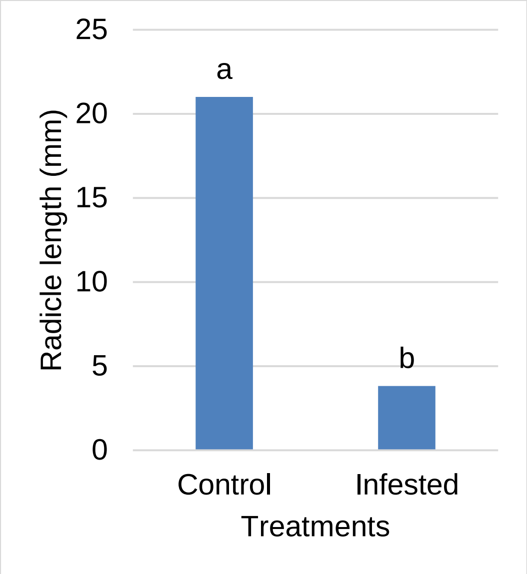


Figure 5.5: Mean comparison for the interaction between infested soils and stored soils on the germination percentage of *Lactuca sativa*.

Figure 5.6: Mean comparison for the interaction between infested soils and stored soils and season of soil collection on germination percentage of *Lactuca sativa*.



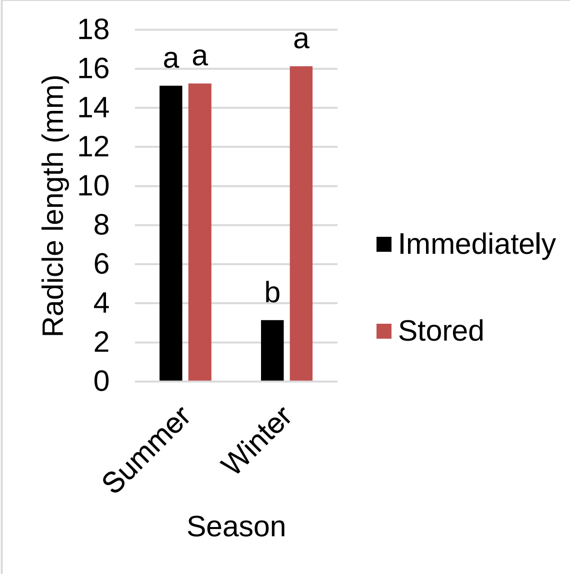


Figure 5.7: Mean comparison for the effect of infested soils on the radicle length of *Lactuca sativa*.

Figure 5.8: Mean comparison for the interaction between stored soils and season of soil collection on the radicle length of *Lactuca sativa*.

5.3.2 *Eragrostis curvula*

5.3.2.1 Days to first germination

Days to first germination were not significant ($P \geq 0.05$) (Annexure C - Table C2.1.2). *Eragrostis curvula* started germinating on day 7 in both infested and non-infested soils collected and used immediately in summer and winter (Table 5.1).

5.3.2.2 Days to maximum germination

Differences in days to maximum germination were not significant ($P \geq 0.05$) (Annexure C - Table C2.2.2). *Eragrostis curvula* reached maximum germination on day 18 where the non-infested soils collected and used immediately in summer were used and reached maximum germination on day 17 where non-infested soils collected in winter and stored were used (Table 5.1). *Eragrostis curvula* reached maximum germination on day 17 where the infested soils collected and used immediately in summer and winter were used, but reached maximum germination on day 19 where infested soils collected in summer and stored were used, while it reached maximum germination on day 18 on infested soils collected in winter and stored (Table 5.1).

5.3.2.3 Germination percentage

Differences in germination percentage were highly significant ($P \leq 0.01$; Figure 5.9, Figure 5.10, and Figure 5.11) between infested soils, the interaction between season and infested soils as well as the interaction between season and stored soils (Annexure C - Table C2.3.2). The interaction between infested soils and stored soils was significant ($P \leq 0.05$; Figure 5.12). Other factors were not significant ($P \geq 0.05$). Infested soils (62.67%), the interaction between infested soils and season (10.09%), the interaction between season and stored soils (8.32%), and the interaction between stored soils and infested soils (2.97%) comprised 84.05% of the total deviance.

Significant differences occurred between the between infested soils (Annexure C - Table C2.3.3). However, where the interaction between infested soils and season were concerned, infested soil collected summer and winter were significantly different from non-infested soils. Where the interaction between stored soils and season were concerned, Soils collected and used immediately in summer and winter were significantly different from stored soils. Where the interaction between infested soils and stored soils were concerned, soils collected and stored and also soils collected and used immediately as well as infested soils were significantly different to un-infested soils. *Eragrostis curvula* had a germination percentage of 83% where un-infested soils collected and used immediately in summer were used and 85% where non infested soils collected in summer and stored were used. It had a germination percentage of 97% where non infested soils collected and used immediately in winter were used and 100% where non infested soils collected in winter and stored were used. *Eragrostis curvula* had a germination percentage of 69% where infested soils collected and used immediately in summer were used and 43% where infested soils collected in summer and stored were used. It had a germination percentage of 41% where infested soils collected and used immediately in winter were used and 64% where infested soils collected in winter and stored were used (Table 5.1).

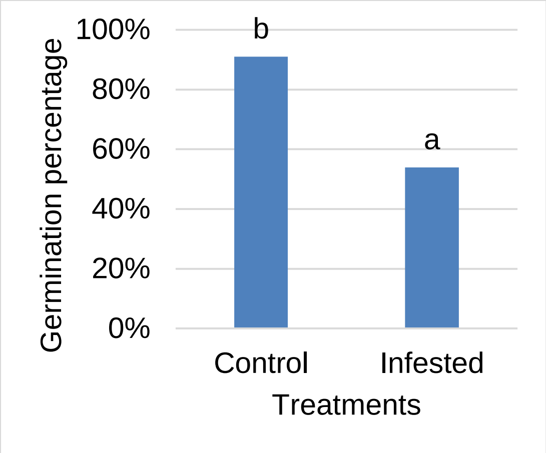
5.3.2.4 Radicle length

Differences in radicle length were highly significant ($P \leq 0.01$; Figure 6.12) between infested soils (Annexure C - Table C2.4.2). All other factors were not significant ($P \geq 0.05$). Infested soils comprised 75.60% of the total deviance. Significant differences occurred between the infested soils (Annexure C - Table C2.4.3). *Eragrostis curvula* reached a radicle length of 9 mm where non infested soils collected and used immediately in summer were used and 10 mm where non infested soils collected in summer and stored were used. It reached a radicle length of 9 mm where non infested soils collected and used immediately in winter were used and 11 mm where non infested soils collected in winter and stored were used. *Eragrostis curvula* reached a radicle length of 2 mm where infested soils collected and used immediately in summer were used and also where infested soils collected in summer and stored were used. It reached a radicle length of 3 mm where infested soils collected and used immediately in winter were used and 2 mm where infested soils collected in winter and stored were used (Table 5.1).

Where infested soils were concerned, infested and non-infested soils had similar inhibitory effects on days to first and maximum germination, but infested soils had a bigger inhibitory effect on the germination percentage and radicle length.

Where stored soils were concerned, fresh and stored soils had similar inhibitory effects on days to first and maximum germination and on the germination percentage and radicle length.

Where seasons were concerned, summer and winter collected soils had similar inhibitory effects on days to first and maximum germination, as well as on the germination percentage and radicle length.



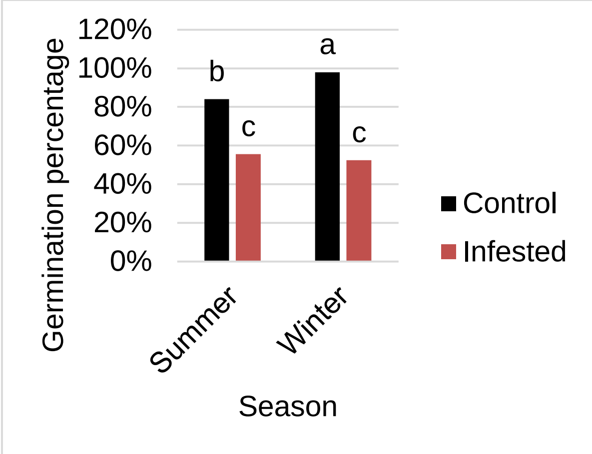
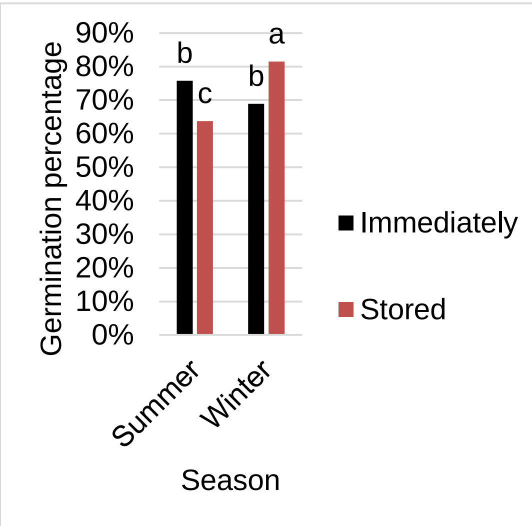


Figure 5.9: Mean comparison for the effect of infested soils on the germination percentage of *Eragrostis curvula*.

Figure 5.10: Mean comparison for the interaction between infested soils and season of soil collection on the germination percentage of *Eragrostis curvula*.



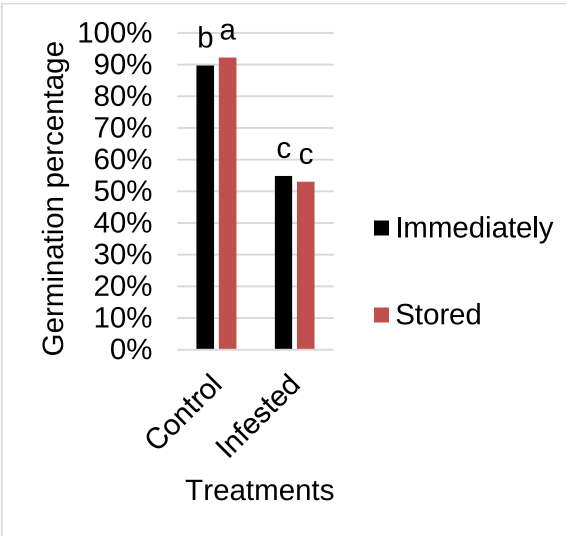


Figure 5.11: Mean comparison for the interaction between stored soils and season of soil collection on the germination percentage of *Eragrostis curvula*.

Figure 5.12: Mean comparison for the interaction between infested soils and stored soils on the germination percentage of *Eragrostis curvula*.

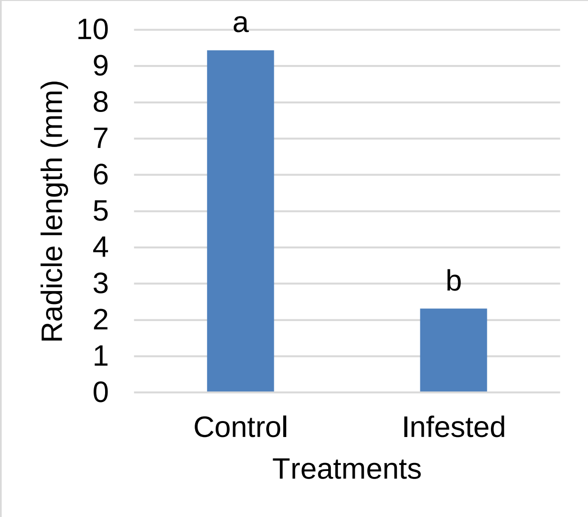


Figure 5.13: Mean comparison for the effect of infested soils on the radicle length of *Eragrostis curvula*.

5.3.3 *Eragrostis tef*

5.3.3.1 Days to first germination

Days to first germination were not significant (P ≥ 0.05) (Annexure C - Table C3.1.2). *Eragrostis tef* started germinating on day 6 where non infested soils collected and used immediately in summer were used and on day 7 where all other non-infested and infested soils were used (Table 5.1).

5.3.3.2 Days to maximum germination

Differences in days to maximum germination were not significant (P ≥ 0.05) (Annexure C - Table C3.2.2). *Eragrostis tef* reached maximum germination on day 17 where the non-infested soils collected in summer and used immediately were applied and also where non-infested soils collected in winter and used immediately were used. It reached maximum germination on day 18 where non-infested soils collected in winter and stored were used (Table 5.1). *Eragrostis tef* reached maximum germination on day 19 where the infested soils collected and stored in summer and winter were used, but reached maximum germination on day 17 where infested soils collected in winter and stored were used (Table 5.1).

5.3.3.3 Germination percentage

Differences in germination percentage were highly significant ($P \leq 0.01$; Figures 5.14 - 5.20) between infested soils, seasons, stored soils and the interaction between infested soils and season, and the interaction between season and stored soils, and the interaction between infested soils and stored soils, as well as the interaction between infested soils and stored soils and season (Annexure C - Table C3.3.2). Infested soils (51.84%), seasons (13.24%), stored soils (12.24%) and the interaction between infested soils and season (3.39%), and the interaction between season and stored soils (4.53%), and the interaction between infested soils and stored soils (3.96%), as well as the interaction between infested soils and stored soils and season (4.64%), comprised 93.84% of the total deviance.

Significant difference occurred between the between infested soils (Annexure C - Table C3.3.3), seasons (Annexure C - Table C3.3.4), stored soils (Annexure C - Table C3.3.6). However, where the interaction between infested soils and season were concerned, infested soils collected in summer was significantly different from infested soils collected in winter and they were both significantly different from non-infested soils (Annexure C - Table C3.3.5). Where the interaction between season and stored were concerned, winter collected soils and used immediately was significantly different from other treatments. Where the interaction between infested soils and stored soils were concerned, infested soils collected and used immediately was significantly different from infested soils collected and stored and they were both significantly different from other treatments. Where the interaction between infested soils and stored soils and season were concerned, infested soils collected in winter and stored was significantly different from infested soils collected and used immediately in winter, and also different from infested soils collected in summer, and they were all significantly different from the control treatments (Annexure C - Table C3.3.9).

Eragrostis tef had a germination percentage of 88%, where non infested soils collected and used immediately in summer (were used) and 86% where non-infested soils collected in summer and stored (were used). It had a germination percentage of 96% where non-infested soils collected and used immediately in winter were used and 89% where non infested soils collected in winter and stored were applied.

Eragrostis tef had a germination percentage of 74% where infested soils collected in summer were applied. It had a germination percentage of 15% where infested soils collected and used immediately in winter were used and 56% where infested soils collected in winter and stored were used (Table 5.1).

5.3.3.4 Radicle length

Differences in radicle length were highly significant ($P \leq 0.01$; Figure 5.21 - 5.23) between infested soils and the interaction between stored soils and infested soils as well as the interaction between infested soils and stored soils and season (Annexure C - Table C3.4.2). All other factors were not significant. Infested soils (69.75%) and the interaction between stored soils and infested soils (5.08%), and the interaction between infested soils and stored soils and season (6.18%) comprised 81.01% of the total deviance.

Significant differences occurred between the infested soils (Annexure C - Table C3.4.3). However, where the interaction between stored soils and infested soils were concerned, infested soils which were stored were significantly different from infested soils which were used immediately and they were both significantly different from the control treatments (Annexure C - Table C3.4.8). Where the interaction between stored soils and infested soils and season were concerned, infested which were collected in winter and stored were significantly different from other infested soils and they were all significantly different from the control treatments (Annexure C - Table C3.4.9).

Eragrostis tef reached a radicle length of 16 mm where non infested soils collected in summer were used. It reached a radicle length of 15 mm where non infested soils collected and used immediately in winter were used and 16 mm where non infested soils collected in winter and stored were used. *Eragrostis tef* reached a radicle length of 6 mm where infested soils collected and used immediately in summer were used, and 5 mm where infested soils collected in summer and stored were used. It reached a radicle length of 6 mm where infested soils collected and used immediately in winter were used, and 2 mm where infested soils collected in winter and stored were used (Table 5.1).

Where infested soils were concerned, infested soils and non-infested soils had similar inhibitory effects on days to first and maximum germination, but infested soils had a bigger inhibitory effect on the germination percentage and radicle length.

Where stored soils were concerned, fresh and stored soils had similar inhibitory effects on days to first and maximum germination and also on the radicle length, but stored soils had a bigger inhibitory effects on the germination percentage.

Where seasons were concerned, summer and winter collected soils had similar inhibitory effects on days to first and maximum germination and also on the radicle length, but winter had a bigger inhibitory effect on the germination percentage.

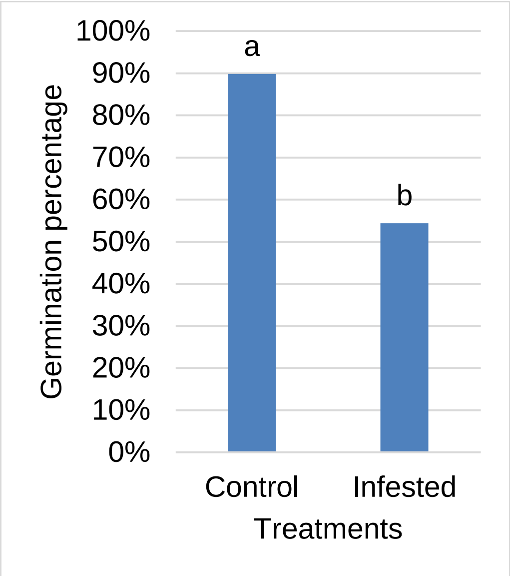


Figure 5.14: Mean comparison for the effect of infested soils on the germination percentage of *Eragrostis tef*.

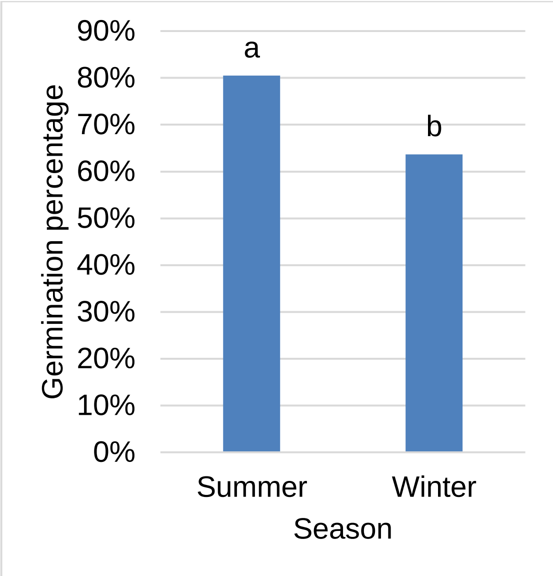


Figure 5.15: Mean comparison for the effect of season of soil collection on the germination percentage of *Eragrostis tef*.

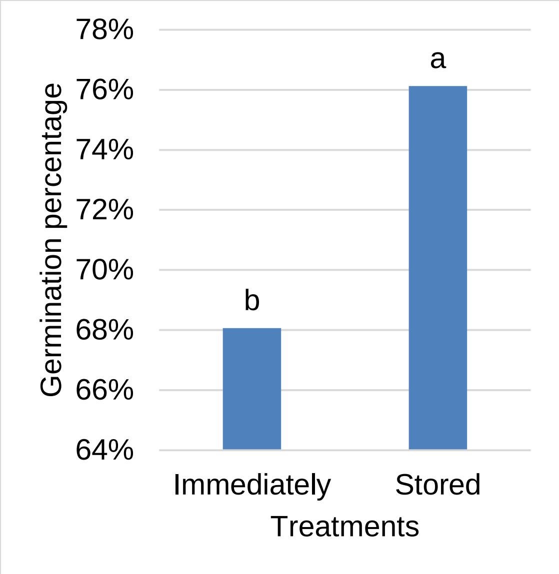


Figure 5.16: Mean comparison for the effect of stored soils on the germination percentage of *Eragrostis tef*.

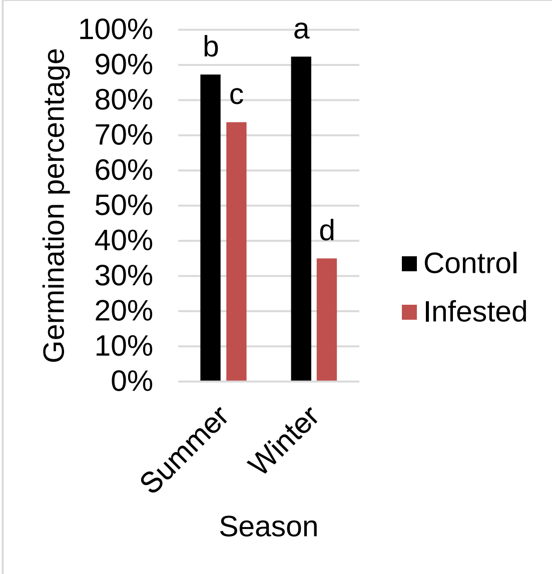


Figure 5.17: Mean comparison for the interaction between infested soils and season of soil collection on the germination percentage of *Eragrostis tef*.

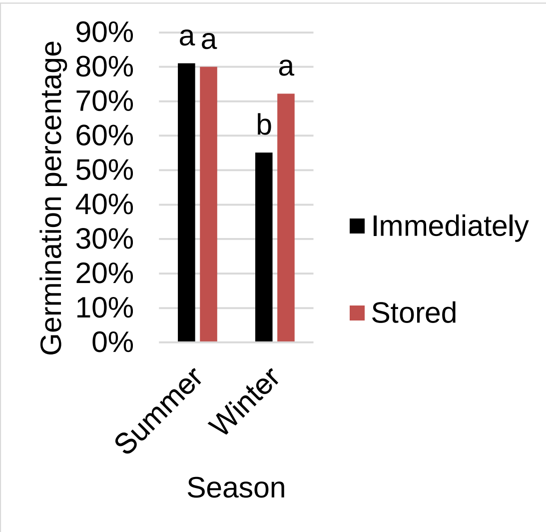


Figure 5.18: Mean comparison for the interaction between season of soil collection and stored soils on the germination percentage of *Eragrostis tef*.

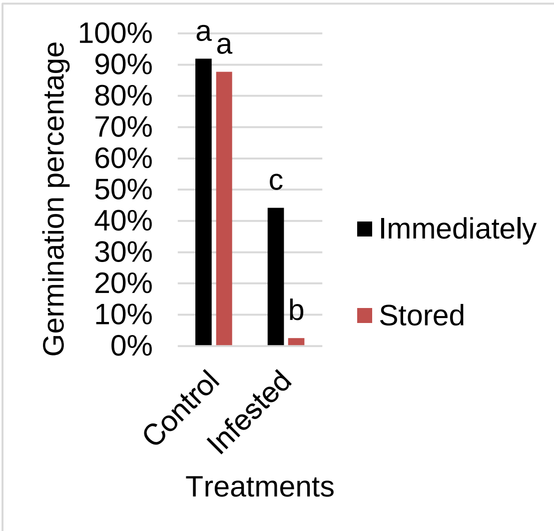
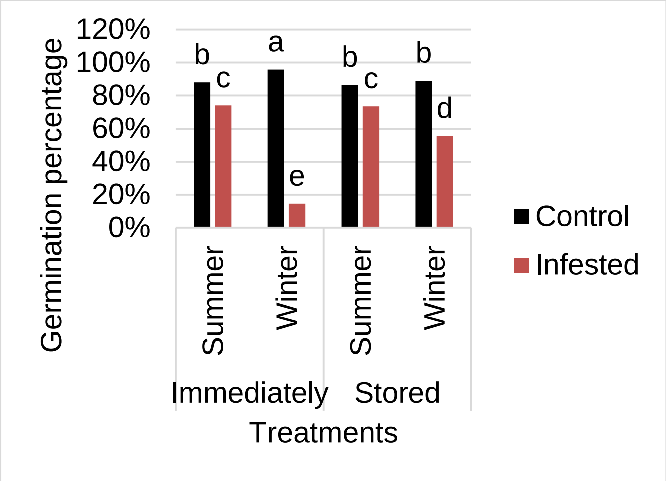


Figure 5.19: Mean comparison for the interaction between infested soils and stored soils on the germination percentage of *Eragrostis tef*.



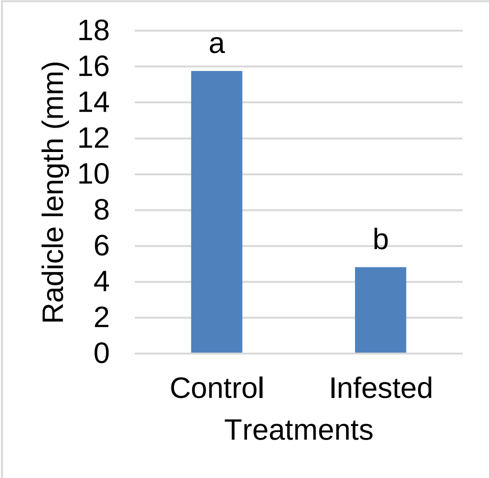
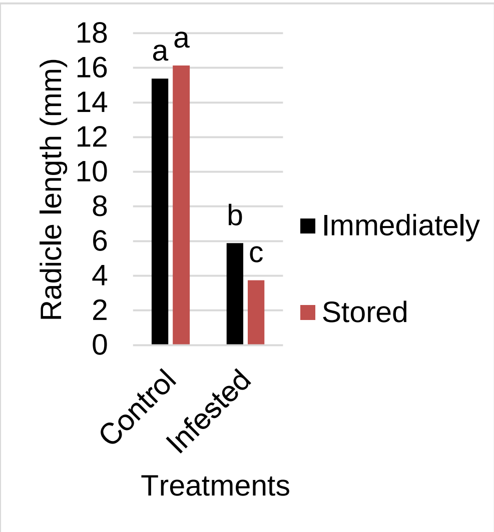


Figure 5.20: Mean comparison for the interaction between infested soils and stored soils and season of soil collection on the germination percentage of *Eragrostis tef*.

Figure 5.21: Mean comparison for the effect of infested soils on the radicle length of *Eragrostis tef*.



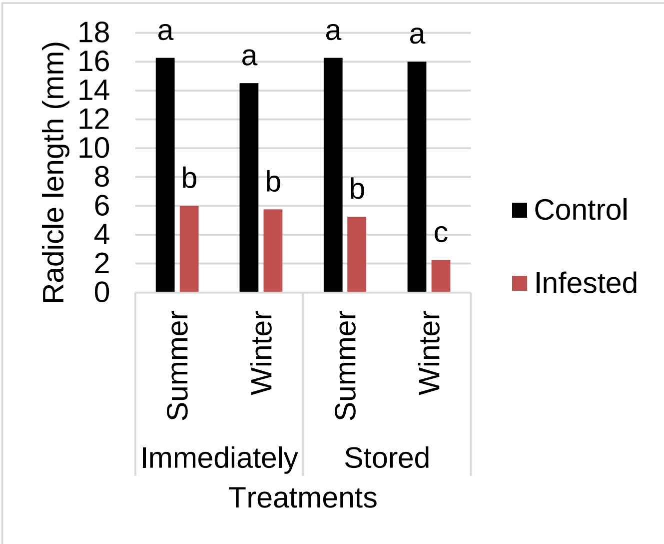


Figure 5.22: Mean comparison for the interaction between stored soils and infested soils on the radicle length of *Eragrostis tef*.

Figure 5.23: Mean comparison for the interaction between infested soils and stored soils and season of soil collection on the radicle length of *Eragrostis tef*.

5.3.4 *Panicum maximum*

5.3.4.1 Days to first germination

Differences in germination percentage were significant ($P \leq 0.05$; Figure 5.24) between infested soils (Annexure C - Table C4.3.2). Other factors were not significant ($P \geq 0.05$). Infested soils comprised 44.96% of the total deviation. *Panicum maximum* started germinating on day 9 where non-infested soils collected and used immediately in summer were used and day 11 where non-infested soils collected and used immediately in winter were used. It started germinating on day 13 where infested soils collected in summer were used and also where infested soils collected and used immediately in winter were used, but it started germinating on day 11 where infested soils collected and stored soils in winter were used (Table 5.1).

5.3.4.2 Days to maximum germination

Differences in days to maximum germination were not significant ($P \geq 0.05$) (Annexure C - Table C4.2.2). *Panicum maximum* reached maximum germination on day 19 where non-infested soils collected and used immediately in summer were used and day 17 where non-infested soils collected and used immediately in winter were used and day 18 where non-infested soils collected in winter and stored were used. It reached maximum germination on day 18 where all infested soils collected in summer and winter and stored were used (Table 5.1).

5.3.4.3 Germination percentage

Differences in germination percentage were highly significant ($P \leq 0.01$; Figure 5.25 - 5.29) between infested soils, seasons and the interaction between infested soils and season, and the interaction between infested soils and stored soils, and the interaction between infested soils and stored soils and season (Annexure C - Table C4.3.2). Infested soils (81.36%), seasons (2.58%) and the interaction between infested soils and season (5.66%), and the interaction between infested soils and stored soils (2.17%), as well as the interaction between infested soils and stored soils and season (2.36%) comprised 94.13% of the total deviance.

Significant differences occurred between the between infested soils (Annexure C - Table C4.3.3), seasons (Annexure C - Table C4.3.4). However where the interaction between infested soils and season were concerned, infested soils collected in summer were significantly different from infested soils collected in winter and they were both significantly different from non-infested soils (Annexure C - Table C4.3.5). Where the interaction between infested soils and stored soils were concerned, infested soils collected and used immediately and infested soils collected and stored were both significantly different from the control treatments (Annexure C - Table C4.3.8). Where the interaction between infested soils and stored soils and season were concerned, infested soils collected in winter were significantly different from infested soils collected in summer, and they were all significantly different from the control treatments (Annexure C - Table C3.3.9).

Panicum maximum had a germination rate of 78% where non infested soils collected and used immediately in summer were used and 79% where non infested soils collected in summer and stored were used. It had a germination percentage of 92% where non infested soils collected and used immediately in winter were used and 74% where non infested soils collected in winter and stored were used. *Panicum maximum* had a germination percentage of 37% where infested soils collected and used immediately in summer were used and 41% where infested soils collected in summer and stored were used. It had a germination percentage of 14% where infested soils collected and used immediately in winter were used and 22% where infested soils collected in winter and stored were used (Table 5.1).

5.3.4.4 Radicle length

Differences in radicle length were highly significant ($P \leq 0.01$; Figure 5.30) between infested soils (Annexure C - Table C4.4.2). Season and the interaction between infested soils and season and the interaction between infested soils and stored soils as well as the interaction between infested soils and stored soils and season were significant ($P \leq 0.05$; Figure 5.31 - 5.34). All other factors were not significant ($P \geq 0.05$). Infested soils (63.89%), season (3.67%), and the interaction between stored soils and infested soils (4.05%) and the interaction between infested soils and stored soils (3.94%) and the interaction between infested soils and stored soils and season (5.07%) comprised 80.62% of the total deviance.

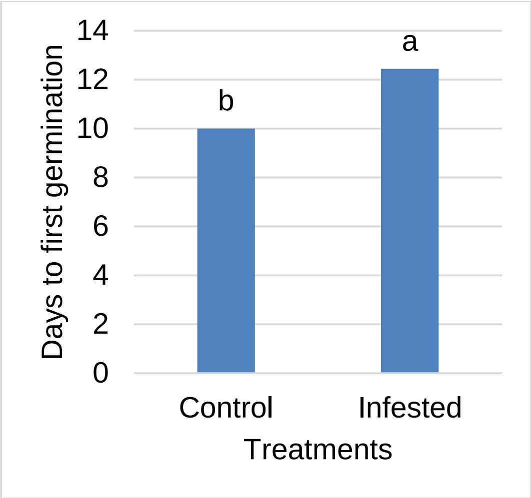
Significant differences occurred between the infested soils (Annexure C - Table C4.4.3) and between seasons (Annexure C - Table C4.4.4). However, where the interaction between infested soils and season were concerned, infested soils collected in summer were significantly different from infested soils collected in winter and they were both significantly different from the control treatments. Where the interaction between stored soils and infested soils were concerned, infested soils which were collected and stored were significantly different from infested soils which were collected and used immediately and they were both significantly different from the control treatments (Annexure C - Table C4.4.8). Where the interaction between stored soils and infested soils and season were concerned, infested soils which were collected in winter and stored were significantly different from other infested soils and they were all significantly different from the control treatments (Annexure C - Table C4.4.9).

Panicum maximum reached a radicle length of 10 mm where non infested soils collected in summer were used. It reached a radicle length of 8 mm where non infested soils collected in winter were used. *Panicum maximum* reached a radicle length of 4 mm where infested soils collected in summer were used. It reached a radicle length of 3 mm where infested soils collected and used immediately in winter were used and 2 mm where infested soils collected in winter and stored were used (Table 5.1).

Where infested were concerned, infested soils had a bigger inhibitory effect on days to first germination and germination percentage, but infested and non-infested soils had similar inhibitory effect on days to maximum germination and radicle length.

Where stored soils were concerned, fresh and stored soils had similar inhibitory effects on days to first and maximum germination, as well as on the germination percentage and radicle length.

Where seasons were concerned, summer and winter collected soils had similar inhibitory effects on days to first and maximum germination, but winter collected soils had a bigger inhibitory effect on the germination percentage and radicle length.



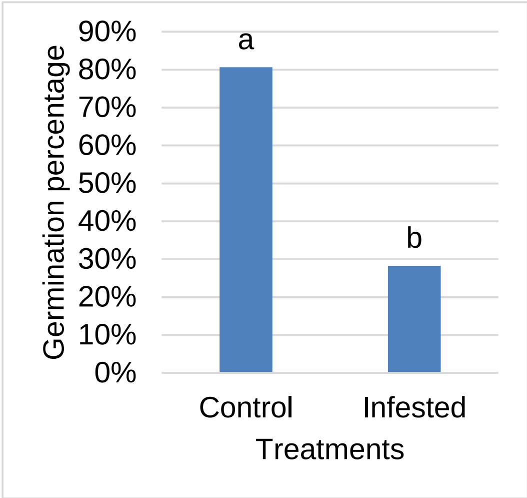
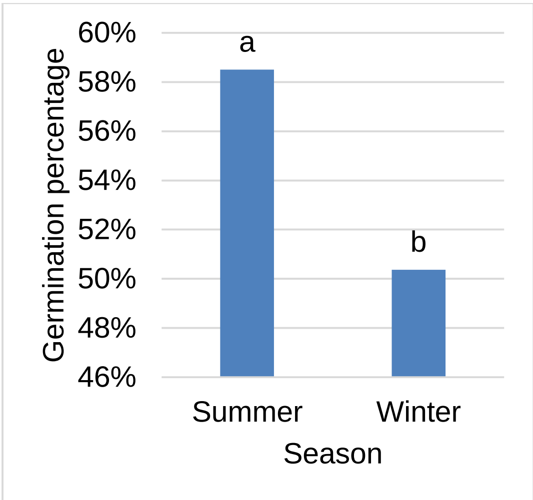


Figure 5.24: Mean comparison for the effect of infested soils on days to first germination of *Panicum maximum*.

Figure 5.25: Mean comparison for the effect of infested soils on the germination percentage of *Panicum maximum*.



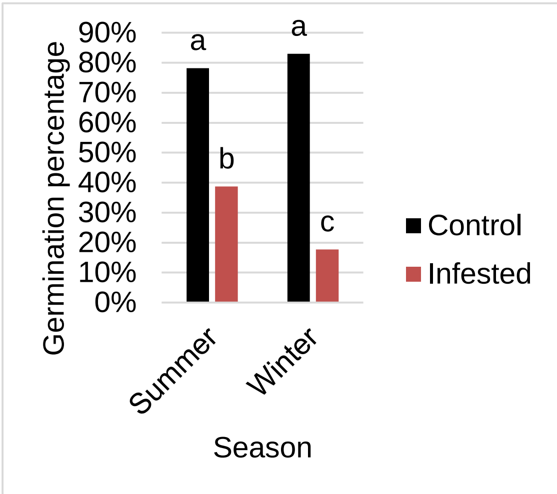


Figure 5.26: Mean comparison for the effect of season of soil collection on the germination percentage of *Panicum maximum*.

Figure 5.27: Mean comparison for the interaction between infested soils and season of soil collection on the germination percentage of *Panicum maximum*.

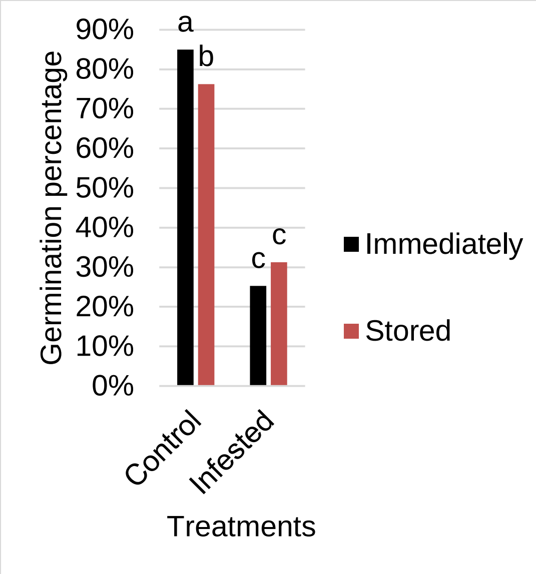


Figure 5.28: Mean comparison for the interaction between infested soils and stored soils on the germination percentage of *Panicum maximum*.

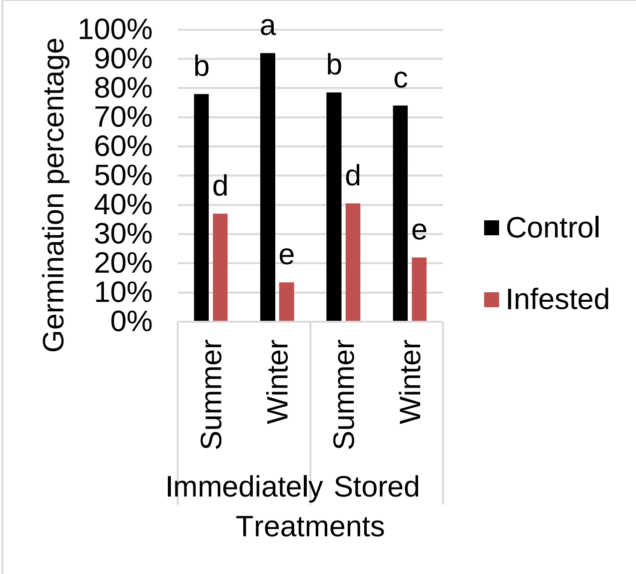


Figure 5.29: Mean comparison for the interaction between infested soils and stored soils and season of soil collection on the germination percentage of *Panicum maximum*.

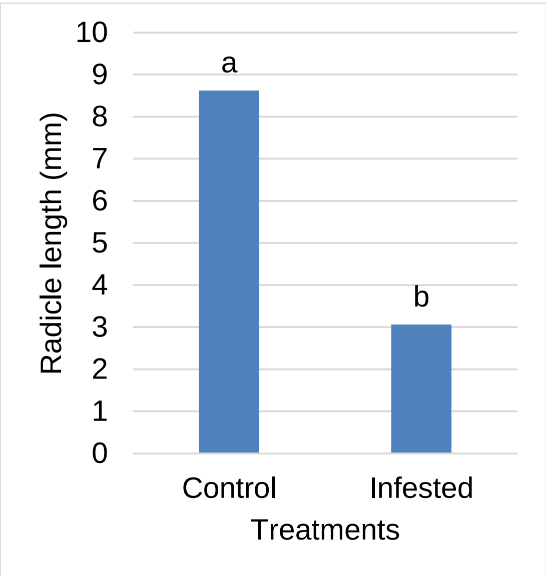


Figure 5.30: Mean comparison for the effect of infested soils on the radicle length of *Panicum maximum*.

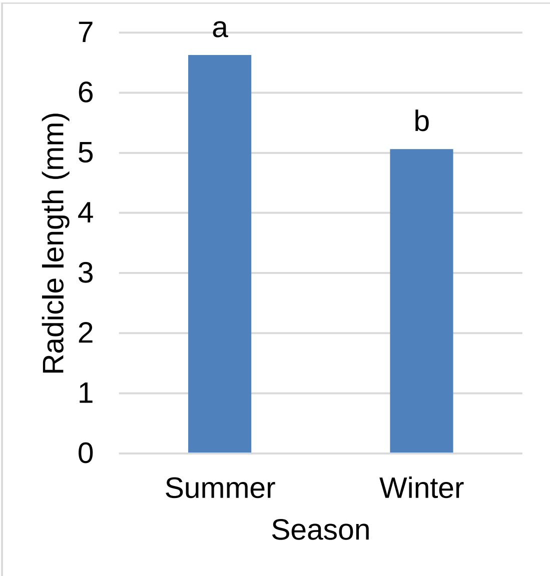


Figure 5.31: Mean comparison for the effect of season of soil collection on the radicle length of *Panicum maximum*.

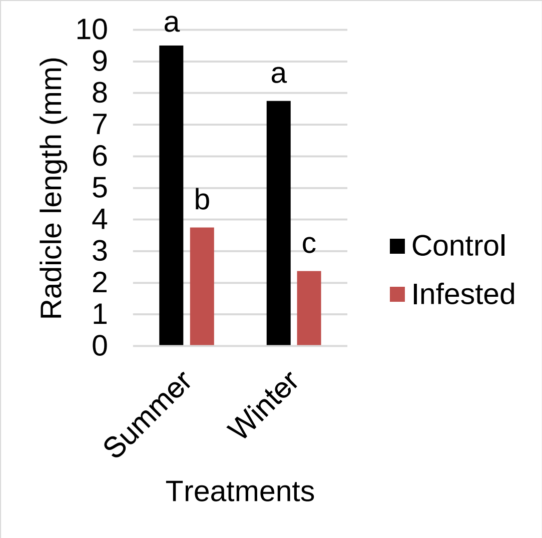


Figure 5.32: Mean comparison for the interaction between season of soil collection and infested soils on the radicle length of *Panicum maximum*.

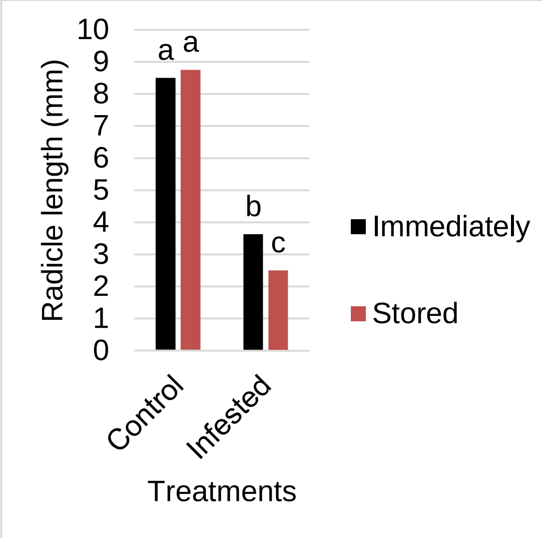


Figure 5.33: Mean comparison for the interaction between infested soils and stored soils on the radicle length of *Panicum maximum*.

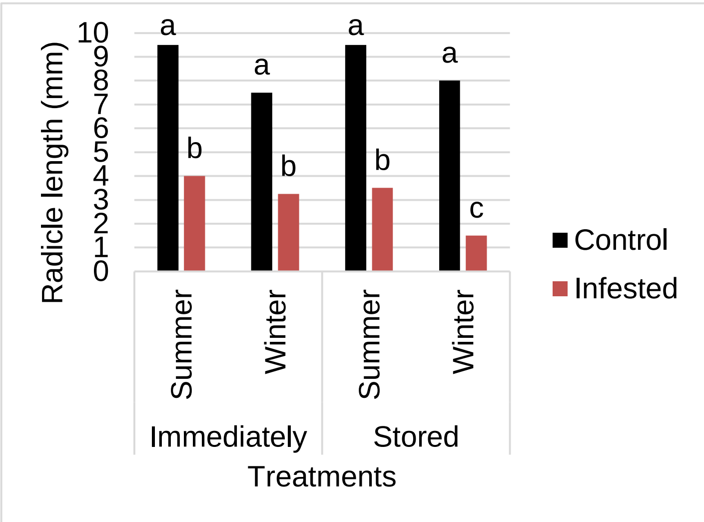


Figure 5.34: Mean comparison for the interaction between infested soils and stored soils and season of soil collection on the radicle length of *Panicum maximum*.

Table 5.1: Average germination and radicle length for infested soils, stored soils and seasons.

Variables	Season		*L. sativa*		*E. curvula*		*E. tef*		*P. maximum*	
			Infested	Non-infested	Infested	Non-infested	Infested	Non-infested	Infested	Non-infested
Days to first germination	Summer	Immediately	7	7	7	7	7	6	13	9
		Stored	7	7	7	7	7	7	13	9
	Winter	Immediately	6	7	7	7	7	7	13	11
		Stored	6	7	7	7	7	7	11	11
Days to maximum germination	Summer	Immediately	19	17	17	18	19	17	18	19
		Stored	19	17	19	18	19	17	18	19
	Winter	Immediately	12	17	17	17	17	17	18	17
		Stored	17	16	18	17	17	18	18	18
Germination percent	Summer	Immediately	72	87	69	83	74	88	37	78
		Stored	63	87	43	85	74	86	41	79
	Winter	Immediately	48	41	41	97	15	96	14	92
		Stored	69	98	64	100	56	89	22	74
Radicle length	Summer	Immediately	3	27	2	9	6	16	4	10
		Stored	3	27	2	10	5	16	4	10
	Winter	Immediately	4	3	3	9	6	15	3	8
		Stored	5	27	2	11	2	16	2	8

5.4 Discussion

Infested soils delayed days to first germination of *P. maximum*. However, infested soils and non-infested soils had similar inhibitory effects on days to first germination of *L. sativa, E. curvula* and *E. tef*. Infested soils and non-infested soils had similar inhibitory effects on days to maximum germination of all the receiver species. Whether infested or non-infested soils were used on the three species, they started germinating and reached maximum germination more or less at the same time. Infested soils caused a low germination percentage and a short radicle length of all the receiver species, but not of *P. maximum*. This was in agreement with Snyman (2010), who found that the soil collected underneath *S. plumosum* shrubs inhibited seedling emergence of *L*. *sativa* and *E*. *curvula*.

Where stored soils were concerned, fresh and stored soils had similar inhibitory effects on days to first and maximum germination of all the species. Whether fresh or stored soils were used on all the species, they started germinating and reached maximum germination more or less at the same time. The stored soils caused a low germination percentage of *L. sativa* and *E. tef*. However, fresh and stored soils had similar inhibitory effects on the germination percentage of *E. curvula* and *P. maximum*. Fresh and stored soils had similar inhibitory effects in the radicle length of all the receiver species.

Where seasons were concerned, summer and winter collected soils had similar inhibitory effects on days to first and maximum germination of all the species. Whether summer or winter collected soils were used on all the species, they started germinating and reached maximum germination more or less at the same time. Winter collected soils caused a low germination percentage of *E. tef* and *P. maximum*, but summer and winter collected soils had similar inhibitory effects on the germination percentage of *L. sativa* and *E. curvula*. Winter collected soils had a bigger inhibitory effect on the radicle length of *P. maximum*, but winter and summer collected soils had similar inhibitory effects on the radicle length of *L. sativa*, *E. curvula* and *E. tef*.

5.5 Conclusions

To summarize, the infested soils had a big effect on the germination and radicle length of all four species, while the non-infested soils had no effect, which proved that infested soils had allelopathic effect on the germination of the receiver species.

The stored soils caused a low germination percentage of *L. sativa* and *E. tef*, which proved that allelopathic effect remain active on infested soils for four months or more.

Winter collected soils caused a low germination percentage and a short radicle length of *E. tef* and *P. maximum*. The reason for the allelopathic effect to be more effective in winter is the same as in chapter 3 and chapter 4 whereby shortage of rain in winter led to the accumulation of this allelochemicals. Should a farmer control this species by means of cutting, it should be quickly removed to allow the gass to recover. The farmer must not expect quick recovery of grasses due to the presence of allelopathic substances in the soil.

CHAPTER 6
GENERAL CONCLUSION AND RECOMMENDATIONS

The duration that the allelopathic agent, from both fresh and stored *S. plumosum* plant material, remained active in the shoots and roots, was investigated in this study and it was surprising that the allelochemicals still remained in stored plant material of *S. plumosum* after a four month storage period. It can be concluded that the shoot material need to be controlled and removed from the side even when using chemicals, there is a need of removing these plant materials from the side since they remain allelopathic after being cut and stored for four months.

Where plant parts were concerned, all the receiver species were sensitive to roots and shoots infusions, but the shoots infusion proved to have a bigger inhibitory effect than the roots infusion. Where seasons were concerned, all the receiver species were sensitive to both summer and winter infusions, but plant material collected in winter proved to have a bigger inhibitory effect than summer collected plant material. The reason was not clear, but it could be speculated that allelochemicals build-up occurred during the latter part of the grazing season, after rain stopped. There could have been higher allelochemical concentrations in plant material in winter compared to summer due to continued leaching of allelochemicals out of plants during the rainy season.

All receiver species were sensitive to infested soils that were collected during both summer and winter. All the receiver species were sensitive to infested soils and seedling germination was inhibited compared to the non-infested soils, which had no effect. Where stored infested soils were concerned, all the receiver species were sensitive to both freshly collected and stored infested soils. Future research is needed to fill the gap of identifying the possible allelochemicals involve in the inhibitory effect of *S. plumosum*. Both plant materials of *S. plumosum* and soils from areas encroached by *S. plumosum* had a negative effect on seedling germination of the four receiver species. Should a farmer control this species by means of cutting, it should be quickly removed to allow the gass to recover. The farmer must not expect quick recovery of grasses due to the presence of allelopathic substances in the soil.

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Annexure A – Data analysis for Infusions with fresh plant materials

A1: *Lactuca sativa*

A1.1: GLM factorial analysis of days to first germination

A1.1.1: Regression analysis

Response variate: Days to first germination
Distribution: Poisson
Link function: Log
Fitted terms: Constant + Infusion + Plant parts + Plant parts.Infusion + Season + Plant parts.Season + Infusion.Season + Plant parts.Infusion.Season

A1.1.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Infusion	**1**	**37.522**	**37.522**	**12.03**	**0.002**
+ Plant parts	1	4.473	4.473	1.43	0.243
+ Plant parts.Infusion	**1**	**33.128**	**33.128**	**10.62**	**0.003**
+ Season	1	0.210	0.210	0.07	0.797
+ Plant parts.Season	1	0.142	0.142	0.05	0.833
+ Infusion.Season	1	0.049	0.049	0.02	0.902
+ Plant parts.Infusion.Season	1	0.000	0.000	0.00	0.999
Residual	24	74.863	3.119		
Total	31	150.387	4.851		

A1.1.3: Predictions from regression model - Infusions

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Infusion	Prediction	s.e.
0	**5.750a**	**1.1628**
100	**1.688b**	**0.6280**

A1.1.4: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Plant parts	Prediction	s.e.
Roots	4.438a	1.0178
Shoots	3.000a	0.8369

A1.1.5: Predictions from regression model – Plant parts and Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	**5.500a**	**1.3594**	**6.000a**	**1.4199**
100	**3.375a**	**1.0649**	**0.000b**	**0.0046**

A1.1.6: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Season		
Summer	3.563a	0.7867
Winter	3.875a	0.8205

A1.1.7: Predictions from regression model - Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	4.125	1.219	4.750	1.308
Shoots	3.000	1.039	3.000	1.039

A1.1.8: Predictions from regression model – Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	5.500	1.435	6.000	1.499
100	1.625	0.780	1.750	0.809

A1.1.9: Predictions from regression model – Plant parts, Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Infusion	Season				
0	Summer	5.000	1.975	6.000	2.163
	Winter	6.000	2.163	6.000	2.163
100	Summer	3.250	1.592	0.000	0.007
	Winter	3.500	1.652	0.000	0.007

A1.2: GLM factorial analysis of days to maximum germination

A1.2.1: Regression analysis

Response variate: Days to maximum germination
Distribution: Poisson
Link function: Log
Fitted terms: Constant + Infusion + Plant parts + Plant parts.Infusion + Season + Plant parts.Season + Infusion.Season + Plant parts.Infusion.Season

A1.2.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Infusion	**1**	**158.165**	**158.165**	**50.71**	**<.001**
+ Plant parts	1	3.109	3.109	1.00	0.328
+ Plant parts.Infusion	**1**	**34.318**	**34.318**	**11.00**	**0.003**
+ Season	1	0.958	0.958	0.31	0.585
+ Plant parts.Season	1	0.032	0.032	0.01	0.920
+ Infusion.Season	1	0.279	0.279	0.09	0.768
+ Plant parts.Infusion.Season	1	0.000	0.000	0.00	0.999
Residual	24	74.863	3.119		
Total	31	271.724	8.765		

A1.2.3: Predictions from regression model – Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Infusion		
0	**13.000a**	**1.754**
100	**1.688b**	**0.630**

A1.2.4: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Plant parts		
Roots	8.188a	1.396
Shoots	6.500a	1.244

A1.2.5: Predictions from regression model – Infusion and Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	**13.000a**	**2.102**	**13.000a**	**2.102**
100	**3.375b**	**1.071**	**0.000c**	**0.005**

A1.2.6: Predictions from regression model – Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Season		
Summer	7.813a	1.166
Winter	6.875a	1.094

A1.2.7: Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	8.625	1.765	7.750	1.673
Shoots	7.000	1.590	6.000	1.472

A1.2.8: Predictions from regression model – Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	14.000	2.289	12.000	2.119
100	1.625	0.780	1.750	0.809

A1.2.9: Predictions from regression model – Plant parts, Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Infusion	Season				
0	Summer	14.000	3.304	14.000	3.304
	Winter	12.000	3.059	12.000	3.059
100	Summer	3.250	1.592	0.000	0.007
	Winter	3.500	1.652	0.000	0.007

A1.3: GLM factorial analysis for Germination percentage

A1.3.1: Regression analysis

Response variate: Germination percentage
Binomial totals: Total
Distribution: Binomial
Link function: Logit
Fitted terms: Constant + Infusion + Plant parts + Season + Plant parts.Infusion + Plant parts.Season + Infusion.Season + Plant parts.Infusion.Season

A1.3.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx chi pr
+ Infusion	**1**	**1698.7749**	**1698.7749**	**1698.77**	**<.001**
+ Plant parts	**1**	**6.6987**	**6.6987**	**6.70**	**0.010**
+ Season	**1**	**5.5131**	**5.5131**	**5.51**	**0.019**
+ Plant parts.Infusion	**1**	**1.7149**	**1.7149**	**1.71**	**0.190**
+ Plant parts.Season	1	3.7895	3.7895	3.79	0.052
Residual	26	17.6550	0.6790		
+ Infusion.Season	1	-0.0006	-0.0006	0.00	*
+ Plant parts.Infusion.Season	1	0.0000	0.0000	0.00	0.995
Total	31	1734.1461	55.9402		

A1.3.3: Predictions from regression model - Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Infusion		
0	**0.9112a**	**0.010051**
100	**0.0025b**	**0.001732**

A1.3.4: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Plant parts		
Roots	**0.4700a**	**0.006252**
Shoots	**0.4438b**	**0.008019**

A1.3.5: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Season		
Summer	**0.4450b**	**0.007909**
Winter	**0.4688a**	**0.006335**

A1.3.6: Predictions from regression model – Plant parts and Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	0.9350	0.012296	0.8875	0.015734
100	0.0050	0.003526	0.0000	0.000034

A1.3.7: Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	0.4700	0.009066	0.4700	0.009066
Shoots	0.4200	0.012961	0.4675	0.008716

A1.3.8: Predictions from regression model - Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	0.8875	0.015619	0.9350	0.012326
100	0.0025	0.002494	0.0025	0.002494

A1.3.9: Predictions from regression model – Plant parts, Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Infusion	Season				
0	Summer	0.9350	0.01743	0.8400	0.02592
	Winter	0.9350	0.01743	0.9350	0.01743
100	Summer	0.0050	0.00499	0.0000	0.00005
	Winter	0.0050	0.00499	0.0000	0.00005

A1.4: GLM factorial analysis of Radicle length

A1.4.1: Regression analysis

Response variate: Radicle length
Distribution: Gamma
Link function: Reciprocal
Fitted terms: Constant + Infusion + Plant parts + Plant parts.Infusion + Season + Infusion.Season + Plant parts.Season + Plant parts.Infusion.Season

A1.4.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Infusion	**1**	**53.4861**	**53.4861**	**300.10**	**<.001**
+ Plant parts	**1**	**0.8987**	**0.8987**	**5.04**	**0.034**
+ Plant parts.Infusion	**1**	**1.1307**	**1.1307**	**6.34**	**0.019**
+ Season	**1**	**0.7561**	**0.7561**	**4.24**	**0.050**
+ Infusion.Season	1	0.0023	0.0023	0.01	0.911
+ Plant parts.Season	**1**	**2.2902**	**2.2902**	**12.85**	**0.001**
+ Plant parts.Infusion.Season	1	0.0096	0.0096	0.05	0.818
Residual	24	4.2775	0.1782		
Total	31	62.8510	2.0275		

A1.4.3: Predictions from regression model - Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Infusion	Prediction	s.e.
0	**27.44a**	**2.693**
100	**0.38b**	**0.810**

A1.4.4: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Plant parts	Prediction	s.e.
Roots	**16.00a**	**2.117**
Shoots	**9.81b**	**0.940**

A1.4.5: Predictions from regression model – Plant parts and Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	**31.25a**	**4.836**	**19.62a**	**2.732**
100	**0.75b**	**0.683**	**0.00c**	**0.819**

A1.4.6: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Season		
Summer	**10.00b**	**0.831**
Winter	**15.81a**	**1.904**

A1.4.7: Predictions from regression model – Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	19.62	2.719	31.25	4.916
100	0.38	0.747	0.38	0.747

A1.4.8: Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Season				
Summer	**16.00a**	**2.341**	**4.00c**	**0.060**
Winter	**16.00a**	**2.347**	**15.63b**	**2.337**

A1.4.9: Predictions from regression model – Plant parts, Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Infusion	Season				
0	Summer	31.25	5.807	8.00	1.900
	Winter	31.25	5.807	31.25	6.807
100	Summer	0.75	0.631	0.00	0.789
	Winter	0.75	0.631	0.00	0.789

A2: *Eragrostis curvula*

A2.1: Summary of raw data for Days to first germination

NOTE: No significant differences ($P \leq 0.05$).

A2.2: GLM factorial analysis of Days to maximum germination

A2.2.1: Regression analysis

Response variate: Days to maximum germination
Distribution: Poisson
Link function: Log
Fitted terms: Constant + Season + Plant parts + Plant parts.Season + Infusion + Infusion.Season + Plant parts.Infusion + Plant parts.Infusion.Season

A2.2.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean	deviance ratio	approx F pr.
+ Season	1	6.104	6.104	3.35	0.080
+ Plant parts	1	1.298	1.298	0.71	0.407
+ Plant parts.Season	1	1.648	1.648	0.90	0.351
+ Infusion	1	0.901	0.901	0.49	0.489
+ Infusion.Season	1	3.371	3.371	1.85	0.187
+ Plant parts.Infusion	1	1.724	1.724	0.95	0.341
+ Plant parts.Infusion.Season	1	2.283	2.283	1.25	0.274
Residual	24	43.773	1.824		
Total	31	61.102	1.971		

A2.2.3: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Season		
Summer	12.25a	1.185
Winter	15.50a	1.333

A2.2.4: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Plant parts		
Roots	14.63a	1.301
Shoots	13.13a	1.232

A2.2.5: Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	13.75	1.788	15.50	1.898
Shoots	10.75	1.580	15.50	1.898

A2.2.6: Predictions from regression model - Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Infusion		
0	14.50a	1.310
100	13.25a	1.252

A2.2.7: Predictions from regression model – Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	14.00	1.793	15.00	1.856
100	10.50	1.553	16.00	1.917

A2.2.8: Predictions from regression model - Plant parts and Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	14.50	1.827	14.50	1.827
100	14.75	1.843	11.75	1.644

A2.2.9: Predictions from regression model – Plant parts, Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Infusion	Season				
0	Summer	14.00	2.527	14.00	2.527
	Winter	15.00	2.615	15.00	2.615
100	Summer	13.50	2.481	7.50	1.842
	Winter	16.00	2.701	16.00	2.701

A2.3: GLM factorial analysis of Germination percentage

A2.3.1: Regression analysis

Response variate: Germination percentage
Binomial totals: Total
Distribution: Binomial
Link function: Logit
Fitted terms: Constant + Infusion + Plant parts + Plant parts.Infusion + Season + Plant parts.Season + Infusion.Season + Plant parts.Infusion.Season

A2.3.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Infusion	**1**	**1031.437**	**1031.437**	**707.27**	**<.001**
+ Plant parts	**1**	**10.361**	**10.361**	**7.10**	**0.013**
+ Plant parts.Infusion	**1**	**19.041**	**19.041**	**13.06**	**0.001**
Residual	28	40.834	1.458		
+ Season	1	0.000	0.000	0.00	*
+ Plant parts.Season	1	0.000	0.000	0.00	1.000
+ Infusion.Season	1	0.000	0.000	0.00	1.000
+ Plant parts.Infusion.Season	1	0.000	0.000	0.00	*
Total	31	1101.673	35.538		

A2.3.3: Predictions from regression model - Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Infusion		
0	**0.8400a**	**0.01983**
100	**0.0875b**	**0.01528**

A2.3.4: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Plant parts		
Roots	**0.4900a**	**0.01632**
Shoots	**0.4375b**	**0.01681**

A2.3.5: Predictions from regression model – Plant parts and Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	**0.8400a**	**0.02214**	**0.8400a**	**0.02214**
100	**0.1400b**	**0.02095**	**0.0350c**	**0.01109**

A2.3.6: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Season		
Summer	0.4638a	0.01414
Winter	0.4638a	0.01414

A2.3.7: Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	0.4900	0.02237	0.4900	0.02237
Shoots	0.4375	0.01817	0.4375	0.01817

A2.3.8: Predictions from regression model – Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	0.8400	0.02343	0.8400	0.02343
100	0.0875	0.01774	0.0875	0.01774

A2.3.9: Predictions from regression model – Plant parts, Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Infusion	Season				
0	Summer	0.8400	0.03381	0.8400	0.03381
	Winter	0.8400	0.03381	0.8400	0.03381
100	Summer	0.1400	0.03200	0.0350	0.01693
	Winter	0.1400	0.03200	0.0350	0.01693

A2.4: GLM factorial analysis of Radicle length

A2.4.1: Regression analysis

Response variate: Radicle length
Distribution: Gamma
Link function: Reciprocal
Fitted terms: Constant + Infusion + Plant parts + Plant parts.Infusion + Season + Infusion.Season + Plant parts.Season + Plant parts.Infusion.Season

A2.4.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Infusion	**1**	**13.2582**	**13.2582**	**60.13**	**<.001**
+ Plant parts	1	0.0723	0.0723	0.33	0.572
+ Plant parts.Infusion	**1**	**1.0760**	**1.0760**	**4.88**	**0.037**
Residual	25	5.5126	0.2205		
+ Season	1	0.0000	0.0000	0.00	1.000
+ Infusion.Season	1	0.0000	0.0000	0.00	1.000
+ Plant parts.Season	1	0.0000	0.0000	0.00	1.000
+ Plant parts.Infusion.Season	1	0.0000	0.0000	0.00	*
Total	31	19.9191	0.6426		

A2.4.3: Predictions from regression model - Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Infusion		
0	**8.000a**	**0.0600**
100	**1.375b**	**0.7203**

A2.4.4: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Plant parts		
Roots	5.000a	0.1675
Shoots	4.375a	0.2642

A2.4.5: Predictions from regression model – Plant parts and Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	**8.000a**	**0.4117**	**8.000a**	**0.4117**
100	**2.000b**	**0.5294**	**0.750c**	**0.7257**

A2.4.6: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Season		
Summer	4.688a	0.2549
Winter	4.688a	0.2549

A2.4.7: Predictions from regression model – Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	8.000	0.4650	8.000	0.4650
100	1.375	0.6003	1.375	0.6003

A2.4.8: Predictions from regression model – Plant parts, Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Infusion	Season				
0	Summer	8.000	1.156	8.000	1.156
	Winter	8.000	1.156	8.000	1.156
100	Summer	2.000	0.281	0.750	0.581
	Winter	2.000	0.281	0.750	0.581

A3: *Eragrostis tef*

A3.1: GLM factorial analysis of Days to first germination

A3.1.1: Regression analysis

Response variate: Days to first germination
Distribution: Poisson
Link function: Log
Fitted terms: Constant + Plant parts + Infusion + Plant parts.Infusion + Season + Infusion.Season + Plant parts.Season + Plant parts.Infusion.Season

A3.1.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx chi pr
+ Plant parts	1	5.333E-02	5.333E-02	0.05	0.817
+ Infusion	1	2.617E+00	2.617E+00	2.62	0.106
+ Plant parts.Infusion	**1**	**4.278E+00**	**4.278E+00**	**4.28**	**0.039**
+ Season	1	2.617E+00	2.617E+00	2.62	0.106
+ Infusion.Season	1	1.738E+00	1.738E+00	1.74	0.187
+ Plant parts.Season	1	1.378E-01	1.378E-01	0.14	0.710
+ Plant parts.Infusion.Season	1	3.560E+00	3.560E+00	3.56	0.059
Residual	24	1.776E-15	7.401E-17		
Total	31	1.500E+01	4.839E-01		

Message: ratios are based on dispersion parameter with value 1.

A3.1.3: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Plant parts		
Roots	9.500a	0.7704
Shoots	9.250a	0.7603

A3.1.4: Predictions from regression model - Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Infusion		
0	8.500a	0.7287
100	10.250a	0.8003

A3.1.5: Predictions from regression model – Plant parts and Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Infusion	0		100	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	**7.500b**	**0.968**	**11.500a**	**1.199**
Shoots	**9.500b**	**1.089**	**9.000b**	**1.061**

A3.1.6: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Season		
Summer	8.500	0.7288
Winter	10.250	0.8004

A3.1.7: Predictions from regression model – Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	7.000	0.935	10.000	1.118
100	10.000	1.118	10.500	1.146

A3.1.8: Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	8.500	1.031	10.500	1.146
Shoots	8.500	1.031	10.000	1.118

A3.1.9: Predictions from regression model – Plant parts, Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Infusion	Season				
0	Summer	7.000	1.323	7.000	1.323
	Winter	8.000	1.414	12.000	1.732
100	Summer	10.000	1.581	10.000	1.581
	Winter	13.000	1.803	8.000	1.414

A3.2: GLM factorial analysis of Days to maximum germination

A3.2.1: Regression analysis

Response variate: Days to maximum germination
Distribution: Poisson
Link function: Log
Fitted terms: Constant + Infusion + Season + Infusion.Season + Plant parts + Plant parts.Season + Plant parts.Infusion + Plant parts.Infusion.Season

A3.2.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx chi pr
+ Infusion	1	1.290E-01	1.290E-01	0.13	0.719
+ Season	1	2.066E+00	2.066E+00	2.07	0.151
+ Infusion.Season	1	1.469E-01	1.469E-01	0.15	0.702
+ Plant parts	1	0.000E+00	0.000E+00	0.00	1.000
+ Plant parts.Season	1	-1.821E-14	-1.821E-14	0.00	*
+ Plant parts.Infusion	1	1.291E-01	1.291E-01	0.13	0.719
+ Plant parts.Infusion.Season	1	1.134E-01	1.134E-01	0.11	0.736
Residual	24	8.807E-12	3.670E-13		
Total	31	2.584E+00	8.337E-02		

Message: ratios are based on dispersion parameter with value 1.

A3.2.3: Predictions from regression model - Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Infusion	Prediction	s.e.
0	15.25a	0.9763
100	15.75a	0.9922

A3.2.4: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Prediction	s.e.
Summer	14.50a	0.9520
Winter	16.50a	1.0155

A3.2.5: Predictions from regression model – Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
Infusion	Prediction	s.e.	Prediction	s.e.
0	14.00	1.323	16.50	1.436
100	15.00	1.369	16.50	1.436

A3.2.6: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Plant parts		
Roots	15.50a	0.9843
Shoots	15.50a	0.9843

A3.2.7: Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	14.50	1.346	16.50	1.436
Shoots	14.50	1.346	16.50	1.436

A3.2.8: Predictions from regression model – Plant parts and Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Infusion	0		100	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	15.50	1.392	15.50	1.392
Shoots	15.00	1.369	16.00	1.41

A3.2.9: Predictions from regression model – Plant parts, Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Infusion	Season				
0	Summer	14.00	1.870	14.00	1.870
	Winter	17.00	2.061	16.00	2.000
100	Summer	15.00	1.936	15.00	1.936
	Winter	16.00	2.000	17.00	2.061

A3.3: GLM factorial analysis of Germination percentage

A3.3.1: Regression analysis

Response variate: Germination percentage
Binomial totals: Total
Distribution: Binomial
Link function: Logit

Fitted terms: Constant + Infusion + Plant parts + Plant parts.Infusion + Season + Plant parts.Season + Infusion.Season + Plant parts.Infusion.Season

A3.3.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Infusion	**1**	**193.053**	**193.053**	**45.25**	**<.001**
+ Plant parts	1	2.605	2.605	0.61	0.442
+ Plant parts.Infusion	**1**	**236.834**	**236.834**	**55.51**	**<.001**
+ Season	1	0.000	0.000	0.00	1.000
+ Plant parts.Season	1	0.000	0.000	0.00	1.000
+ Infusion.Season	**1**	**381.916**	**381.916**	**89.51**	**<.001**
+ Plant parts.Infusion.Season	**1**	**144.391**	**144.391**	**33.84**	**<.001**
Residual	24	102.403	4.267		
Total	31	1061.201	34.232		

A3.3.3: Predictions from regression model - Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Infusion	Prediction	s.e.
0	**0.7412a**	**0.08328**
100	**0.4013b**	**0.09322**

A3.3.4: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Plant parts	Prediction	s.e.
Roots	**0.5900a**	**0.08929**
Shoots	**0.5525a**	**0.09010**

A3.3.5: Predictions from regression model – Plant parts and Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	**0.9300a**	**0.06025**	**0.5525b**	**0.11781**
100	**0.2500b**	**0.10259**	**0.5525b**	**0.11781**

A3.3.6: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Season		
Summer	0.5712a	0.07371
Winter	0.5712a	0.07371

A3.3.7: Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	0.5900	0.0873	0.5900	0.0873
Shoots	0.5525	0.1223	0.5525	0.1223

A3.3.8: Predictions from regression model – Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	**0.9300a**	**0.03855**	**0.5525b**	**0.06124**
100	**0.2125c**	**0.06407**	**0.5900b**	**0.06446**

A3.3.9: Predictions from regression model – plant part, Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Infusion	Season				
0	**Summer**	**0.9300a**	**0.03714**	**0.9300a**	**0.03714**
	Winter	**0.9300a**	**0.03714**	**0.1750b**	**0.05550**
100	**Summer**	**0.2500b**	**0.06325**	**0.1750b**	**0.05550**
	Winter	**0.2500b**	**0.06325**	**0.9300a**	**0.03714**

A3.4: GLM factorial analysis of Radicle length

A3.4.1: Regression analysis

Response variate: Radicle length
Distribution: Gamma
Link function: Reciprocal
Fitted terms: Constant + Infusion + Plant parts + Plant parts.Infusion + Season + Infusion.Season + Plant parts.Season + Plant parts.Infusion.Season

A3.4.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Infusion	**1**	**3.3050**	**3.3050**	**6.16**	**0.020**
+ Plant parts	1	0.0381	0.0381	0.07	0.792
+ Plant parts.Infusion	**1**	**5.4835**	**5.4835**	**10.22**	**0.004**
+ Season	1	0.0000	0.0000	0.00	1.000
+ Infusion.Season	**1**	**3.0198**	**3.0198**	**5.63**	**0.026**
+ Plant parts.Season	1	1.1611	1.1611	2.16	0.154
+ Plant parts.Infusion.Season	1	1.2113	1.2113	2.26	0.146
Residual	24	12.8744	0.5364		
Total	31	27.0932	0.8740		

A3.4.3: Predictions from regression model - Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Infusion		
0	**6.813a**	**1.517**
100	**3.563b**	**0.793**

A3.4.4: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Plant parts		
Roots	5.000a	1.182
Shoots	5.375a	1.277

A3.4.5: Predictions from regression model – Plant parts and Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	**8.250a**	**2.353**	**5.375a**	**1.523**
100	**1.750b**	**0.499**	**5.375a**	**1.523**

A3.4.6: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Season		
Summer	5.188a	1.162
Winter	5.188a	1.162

A3.4.7: Predictions from regression model – Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	**8.250a**	**2.290**	**5.375a**	**1.470**
100	**2.125b**	**0.604**	**5.000a**	**1.566**

A3.4.8: Predictions from regression model – Plant parts, Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Infusion	Season				
0	Summer	8.250	3.017	8.250	3.017
	Winter	8.250	3.017	2.500	0.913
100	Summer	1.750	0.639	2.500	0.913
	Winter	1.750	0.639	8.250	3.017

A4: *Panicum maximum*

A4.1: GLM factorial analysis of Days to first germination

A4.1.1 Regression analysis

Response variate: Days to first germination
Distribution: Poisson
Link function: Log
Fitted terms: Constant + Plant parts + Infusion + Plant parts.Infusion + Season + Infusion.Season + Plant parts.Season + Plant parts.Infusion.Season

A4.1.2 Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Plant parts	1	1.979	1.979	1.06	0.314
+ Infusion	1	1.416	1.416	0.76	0.393
+ Plant parts.Infusion	1	1.749	1.749	0.94	0.343
+ Season	1	0.000	0.000	0.00	*
+ Infusion.Season	1	0.000	0.000	0.00	1.000
+ Plant parts.Season	1	0.000	0.000	0.00	*
+ Plant parts.Infusion.Season	1	0.000	0.000	0.00	1.000
Residual	24	44.878	1.870		
Total	31	50.022	1.614		

A4.1.3 Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Plant parts		
Roots	11.50a	1.073
Shoots	9.88a	0.994

A4.1.4 Predictions from regression model - Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Infusion		
0	10.00a	1.002
100	11.38a	1.069

A4.1.5 Predictions from regression model – Plant parts and Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Infusion	0		100	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	10.00	1.415	13.00	1.614
Shoots	10.00	1.415	9.75	1.397

A4.1.6 Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Season		
Summer	10.69a	1.054
Winter	10.69a	1.054

A4.1.7 Predictions from regression model – Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	10.00	1.469	10.00	1.469
100	11.38	1.567	11.38	1.567

A4.1.8 Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Season	Summer Prediction	s.e.	Winter Prediction	s.e.
Plant parts				
Roots	11.50	1.606	11.50	1.606
Shoots	9.88	1.488	9.88	1.488

A4.1.9 Predictions from regression model – Plant parts, Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Plant parts	Roots Prediction	s.e.	Shoots Prediction	s.e.
Infusion	Season				
0	Summer	10.00	2.162	10.00	2.162
	Winter	10.00	2.162	10.00	2.162
100	Summer	13.00	2.465	9.75	2.135
	Winter	13.00	2.465	9.75	2.135

A4.2 GLM factorial analysis of Days to maximum germination

A4.2.1 Regression analysis

Response variate: Days to maximum germination
Distribution: Poisson
Link function: Log
Fitted terms: Constant + Plant parts + Infusion + Plant parts.Infusion + Season + Infusion.Season + Plant parts.Season + Plant parts.Infusion.Season

A4.2.2 Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Plant parts	1	2.068	2.068	0.93	0.345
+ Infusion	1	2.068	2.068	0.93	0.345
+ Plant parts.Infusion	1	2.376	2.376	1.07	0.312
+ Season	1	2.068	2.068	0.93	0.345
+ Infusion.Season	1	0.484	0.484	0.22	0.646
+ Plant parts.Season	1	0.000	0.000	0.00	*
+ Plant parts.Infusion.Season	1	0.000	0.000	0.00	1.000
Residual	24	53.509	2.230		
Total	31	62.573	2.018		

A4.2.3 Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Plant parts		
Roots	15.50a	1.398
Shoots	13.56a	1.307

A4.2.4 Predictions from regression model - Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Infusion		
0	15.50a	1.397
100	13.56a	1.307

A4.2.5 Predictions from regression model – Plant parts and Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Infusion	0		100	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	15.50	1.970	15.50	1.970
Shoots	15.50	1.970	11.63	1.705

A4.2.6 Predictions from regression model – Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Season		
Summer	13.56a	1.302
Winter	15.50a	1.392

A4.2.7 Predictions from regression model – Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	14.00	1.898	17.00	2.091
100	13.13	1.837	14.00	1.898

A4.2.8 Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	14.50	1.970	16.50	2.101
Shoots	12.63	1.838	14.50	1.969

A4.2.9 Predictions from regression model – Plant parts, Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Infusion	Season				
0	Summer	14.00	2.793	14.00	2.793
	Winter	17.00	3.078	17.00	3.078
100	Summer	15.00	2.891	11.25	2.504
	Winter	16.00	2.986	12.00	2.586

A4.3 **GLM factorial analysis of Germination percentage**

A4.3.1 Regression analysis

Response variate: Germination percentage
Binomial totals: Total
Distribution: Binomial
Link function: Logit
Fitted terms: Constant + Infusion + Plant parts + Plant parts.Infusion + Season + Plant parts.Season + Infusion.Season + Plant parts.Infusion.Season

A4.3.2 Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Infusion	**1**	**1089.636**	**1089.636**	**609.03**	**<.001**
+ Plant parts	1	0.623	0.623	0.35	0.560
+ Plant parts.Infusion	1	0.345	0.345	0.19	0.664
+ Season	1	0.025	0.025	0.01	0.907
+ Plant parts.Season	1	0.000	0.000	0.00	0.996
+ Infusion.Season	1	0.045	0.045	0.03	0.875
Residual	25	44.728	1.789		
+ Plant parts.Infusion.Season	1	0.000	0.000	0.00	*
Total	31	1135.402	36.626		

A4.3.3 Predictions from regression model - Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Infusion		
0	**0.9225a**	**0.01168**
100	**0.1525b**	**0.01570**

A4.3.4 Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Plant parts		
Roots	0.5437a	0.01403
Shoots	0.5313a	0.01391

A4.3.5 Predictions from regression model – Plant parts and Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	0.9225	0.01691	0.9225	0.01691
100	0.1650	0.02347	0.1400	0.02194

A4.3.6 Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Season		
Summer	0.5387a	0.01443
Winter	0.5363a	0.01440

A4.3.7 Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	0.5450	0.02124	0.5425	0.02120
Shoots	0.5325	0.02034	0.5300	0.02030

A4.3.8 Predictions from regression model – Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	0.9250	0.01761	0.9200	0.01814
100	0.1525	0.02403	0.1525	0.02403

A4.3.9 Predictions from regression model – Plant parts, Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Infusion	Season				
0	Summer	0.9250	0.02542	0.9250	0.02542
	Winter	0.9200	0.02619	0.9200	0.02619
100	Summer	0.1650	0.03583	0.1400	0.03349
	Winter	0.1650	0.03583	0.1400	0.03349

A4.4 GLM factorial analysis of Radicle length

A4.4.1 Regression analysis

Response variate: Radicle length
Distribution: Gamma
Link function: Reciprocal
Fitted terms: Constant + Infusion + Plant parts + Plant parts.Infusion + Season + Infusion.Season + Plant parts.Season + Plant parts.Infusion.Season

A4.4.2 Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Infusion	**1**	**8.9514**	**8.9514**	**54.73**	**<.001**
+ Plant parts	1	0.0336	0.0336	0.21	0.654
+ Plant parts.Infusion	1	0.2963	0.2963	1.81	0.190
+ Season	1	0.0000	0.0000	0.00	1.000
Residual	27	4.4156	0.1635		
+ Infusion.Season	1	0.0000	0.0000	0.00	*
+ Plant parts.Season	1	0.0000	0.0000	0.00	*
+ Plant parts.Infusion.Season	1	0.0000	0.0000	0.00	*
Total	31	13.6969	0.4418		

A4.4.3 Predictions from regression model - Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Infusion	Prediction	s.e.
0	**6.750a**	**0.2294**
100	**1.625b**	**0.7390**

A4.4.4 Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Plant parts	Prediction	s.e.
Roots	4.375a	0.3934
Shoots	4.000a	0.4405

A4.4.5 Predictions from regression model – Plant parts and Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	6.750	0.0881	6.750	0.0881
100	2.000	0.4788	1.250	0.6841

A4.4.6 Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Season		
Summer	4.188a	0.4144
Winter	4.188a	0.4144

A4.4.7 Predictions from regression model – Infusion and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infusion				
0	7.750	1.1292	7.750	1.1292
100	2.625	0.3863	2.625	0.3863

A4.4.8 Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Infusion	Season				
0	Summer	6.750	0.662	6.750	0.662
	Winter	6.750	0.662	6.750	0.662
100	Summer	2.000	0.357	1.250	0.517
	Winter	2.000	0.357	1.250	0.517

Annexure B – Data analysis for infusions with stored plant materials

B1: *Lactuca sativa*

B1.1: GLM factorial analysis of Days to first germination

B1.1.1: Regression analysis

Response variate:	Days to first germination
Distribution:	Poisson
Link function:	Log

Fitted terms: Constant + Season + Plant parts + Plant parts.Season + Stored + Stored.Season + Plant parts.Stored + Plant parts.Stored.Season

B1.1.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Season	**1**	**17.560**	**17.560**	**4.52**	**0.043**
+ Plant parts	1	4.498	4.498	1.16	0.292
+ Plant parts.Season	**1**	**17.696**	**17.696**	**4.56**	**0.043**
+ Stored	1	1.870	1.870	0.48	0.494
+ Stored.Season	**1**	**19.489**	**19.489**	**5.02**	**0.034**
+ Plant parts.Stored	**1**	**22.080**	**22.080**	**5.69**	**0.025**
Residual	25	97.043	3.882		
+ Plant parts.Stored.Season	1	-0.002	-0.002	0.00	*
Total	31	180.237	5.814		

B1.1.3: Predictions from regression model - Infusion

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Season		
Summer	3.063a	1.0188
Winter	1.000b	0.5807

B1.1.4: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Plant parts		
Roots	2.563a	0.9342
Shoots	1.500a	0.7150

B1.1.5: Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	**3.125a**	**1.4000**	**2.000a**	**1.1200**
Shoots	**3.000a**	**1.3717**	**0.000b**	**0.0103**

B1.1.6: Predictions from regression model – Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Stored		
Fresh	1.688a	0.7358
Stored	2.375a	0.8730

B1.1.7: Predictions from regression model – Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	**1.625b**	**0.9647**	**1.750b**	**1.0011**
Stored	**4.500a**	**1.6054**	**0.250b**	**0.3784**

B1.1.8: Predictions from regression model – Plant parts and Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	**3.375a**	**1.2797**	**0.000b**	**0.0037**
Stored	**1.750b**	**0.9215**	**3.000a**	**1.2065**

B1.1.9: Predictions from regression model – Plant parts and Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Fresh	Summer	3.250	1.813	0.000	0.008
	Winter	3.500	1.881	0.000	0.008
Stored	Summer	3.000	1.741	6.000	2.463
	Winter	0.500	0.711	0.000	0.008

B1.2: GLM factorial analysis of Days to maximum germination

B1.2.1: Regression analysis

Response variate: Days to maximum germination
Distribution: Poisson
Link function: Log
Fitted terms: Constant + Season + Stored + Stored.Season + Plant parts + Plant parts.Season + Plant parts.Stored + Plant parts.Stored.Season

B1.2.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Season	1	18.712	18.712	3.51	0.073
+ Stored	1	16.871	16.871	3.17	0.087
+ Stored.Season	1	10.234	10.234	1.92	0.178
+ Plant parts	1	4.783	4.783	0.90	0.352
+ Plant parts.Season	**1**	**31.627**	**31.627**	**5.94**	**0.022**
+ Plant parts.Stored	**1**	**23.769**	**23.769**	**4.46**	**0.045**
Residual	25	133.088	5.324		
+ Plant parts.Stored.Season	1	-0.001	-0.001	0.00	*
Total	31	239.084	7.712		

B1.2.3: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Season		
Summer	4.188a	1.387
Winter	1.625a	0.861

B1.2.4: Predictions from regression model – Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Stored		
Fresh	1.688a	0.856
Stored	4.125a	1.344

B1.2.5: Predictions from regression model – Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.
Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	1.625	1.181	1.750	1.225
Stored	6.750	2.413	1.500	1.135

B1.2.6: Predictions from regression model - Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Plant parts		
Roots	3.563a	1.246
Shoots	2.250a	0.991

B1.2.7: Predictions from regression model - Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	**3.875a**	**1.709**	**3.250a**	**1.566**
Shoots	**4.500a**	**1.842**	**0.000b**	**0.011**

B1.2.8: Predictions from regression model – Plant parts and Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	**3.375a**	**1.499**	**0.000b**	**0.005**
Stored	**3.750a**	**1.580**	**4.500a**	**1.730**

B1.2.9: Predictions from regression model – Plant parts, Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Fresh	Summer	3.250	2.123	0.000	0.009
	Winter	3.500	2.203	0.000	0.009
Stored	Summer	4.500	2.498	9.000	3.532
	Winter	3.000	2.039	0.000	0.009

B1.3: GLM factorial analysis of Germination percentage

B1.3.1: Regression analysis

Response variate: Germination percentage
Binomial totals: Total
Distribution: Binomial
Link function: Logit
Fitted terms: Constant + Stored + Season + Plant parts + Plant parts.Season + Plant parts.Stored + Stored.Season + Plant parts.Stored.Season

B1.3.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Stored	**1**	**27.324**	**27.324**	**20.13**	**<.001**
+ Season	**1**	**22.737**	**22.737**	**16.75**	**<.001**
+ Plant parts	1	0.000	0.000	0.00	*
+ Plant parts.Season	1	4.532	4.532	3.34	0.080
+ Plant parts.Stored	1	2.977	2.977	2.19	0.151
+ Stored.Season	1	1.126	1.126	0.83	0.371
Residual	25	33.939	1.358		
+ Plant parts.Stored.Season	1	-0.001	-0.001	0.00	*
Total	31	92.635	2.988		

B1.3.3: Predictions from regression model – Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Stored		
Fresh	**0.00250b**	**0.002555**
Stored	**0.03500a**	**0.009565**

B1.3.4: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Season		
Summer	**0.03375a**	**0.007633**
Winter	**0.00375b**	**0.002611**

B1.3.5: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Plant parts		
Roots	0.01875	0.005805
Shoots	0.01875	0.005805

B1.3.6: Predictions from regression model - Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	0.03000	0.010006	0.00750	0.005106
Shoots	0.03750	0.011110	0.00000	0.000048

B1.3.7: Predictions from regression model – Plant parts and Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	0.00500	0.004092	0.00000	0.000030
Stored	0.03250	0.010234	0.03750	0.010815

B1.3.8: Predictions from regression model - Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	0.00250	0.002906	0.00250	0.002906
Stored	0.06500	0.014350	0.00500	0.004099

B1.3.9: Predictions from regression model – Plant parts, Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Fresh	Summer	0.00500	0.005931	0.00000	0.000056
	Winter	0.00500	0.005931	0.00000	0.000056
Stored	Summer	0.05500	0.019170	0.07500	0.022148
	Winter	0.01000	0.008367	0.00000	0.000056

B1.4: GLM factorial analysis of Radicle Length

B1.4.1: Regression analysis

Response variate: Radicle length
Distribution: Gamma
Link function: Reciprocal

Fitted terms: Constant + Stored + Season + Stored.Season + Plant parts + Plant parts.Stored + Plant parts.Season + Plant parts.Stored.Season

B1.4.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Stored	**1**	**2.5872**	**2.5872**	**7.89**	**0.010**
+ Season	**1**	**3.0553**	**3.0553**	**9.32**	**0.005**
+ Stored.Season	1	1.2798	1.2798	3.90	0.060
+ Plant parts	1	0.5579	0.5579	1.70	0.205
+ Plant parts.Stored	1	0.7556	0.7556	2.30	0.142
+ Plant parts.Season	1	0.1658	0.1658	0.51	0.484
+ Plant parts.Stored.Season	1	0.0935	0.0935	0.29	0.598
Residual	24	7.8719	0.3280		
Total	31	16.3670	0.5280		

B1.4.3: Predictions from regression model - Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Stored		
Fresh	**0.375b**	**0.7674**
Stored	**1.438a**	**0.5897**

B1.4.4: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Season		
Summer	**1.500a**	**0.6007**
Winter	**0.313b**	**0.7974**

B1.4.5: Predictions from regression model - Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	0.375	0.7181	0.375	0.7181
Stored	2.625	0.2568	0.250	0.7434

B1.4.6: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Plant parts		
Roots	1.188a	0.6362
Shoots	0.625a	0.7462

B1.4.7: Predictions from regression model – Plant parts and Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	0.750	0.6549	0.000	0.8023
Stored	1.625	0.4237	1.250	0.5100

B1.4.8: Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Season				
Summer	1.750	0.4155	1.250	0.4934
Winter	0.625	0.6740	0.000	0.7999

B1.4.9: Predictions from regression model – Plant parts, Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Fresh	Summer	0.750	0.5003	0.000	0.7136
	Winter	0.750	0.5003	0.000	0.7136
Stored	Summer	2.750	0.0653	2.500	0.0022
	Winter	0.500	0.5707	0.000	0.7136

B2: *Eragrostis curvula*

B2.1: GLM factorial analysis of Days to first germination

B2.1.1: Regression analysis

Response variate:	Days to first germination
Distribution:	Poisson
Link function:	Log

Fitted terms: Constant + Season + Plant parts + Plant parts.Season + Stored + Stored.Season + Plant parts.Stored + Plant parts.Stored.Season

B2.1.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Season	1	2.289	2.289	0.97	0.335
+ Plant parts	1	5.160	5.160	2.18	0.153
+ Plant parts.Season	1	0.085	0.085	0.04	0.851
+ Stored	1	0.572	0.572	0.24	0.628
+ Stored.Season	1	0.005	0.005	0.00	0.963
+ Plant parts.Stored	1	8.548	8.548	3.61	0.070
+ Plant parts.Stored.Season	1	0.065	0.065	0.03	0.870
Residual	24	56.849	2.369		
Total	31	73.574	2.373		

B2.1.3: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Season		
Summer	7.125a	1.029
Winter	8.625a	1.132

B2.1.4: Predictions from regression model - Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Plant parts		
Roots	9.000a	1.133
Shoots	6.750a	0.981

B2.1.5: Predictions from regression model - Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	8.000	1.536	10.000	1.717
Shoots	6.250	1.357	7.250	1.462

B2.1.6: Predictions from regression model - Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Stored		
Fresh	7.500	1.066
Stored	8.250	1.118

B2.1.7: Predictions from regression model - Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	6.750	1.457	8.250	1.611
Stored	7.500	1.536	9.000	1.683

B2.1.8: Predictions from regression model – Plant parts and Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	10.000	1.687	5.000	1.189
Stored	8.000	1.509	8.500	1.555

B2.1.9: Predictions from regression model – Plant parts, Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Fresh	Summer	9.000	2.309	4.500	1.628
	Winter	11.000	2.552	5.500	1.799
Stored	Summer	7.000	2.036	8.000	2.177
	Winter	9.000	2.309	9.000	2.309

B2.2: GLM factorial analysis of Days to maximum germination

B2.2.1: Regression analysis

Response variate: Days to maximum germination
Distribution: Poisson
Link function: Log
Fitted terms: Constant + Plant parts + Stored + Season + Stored.Season + Plant parts.Season + Plant parts.Stored + Plant parts.Stored.Season

B2.2.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Plant parts	1	2.161	2.161	1.09	0.306
+ Stored	1	0.991	0.991	0.50	0.486
+ Season	1	0.020	0.020	0.01	0.920
+ Stored.Season	**1**	**18.725**	**18.725**	**9.46**	**0.005**
+ Plant parts.Season	1	1.389	1.389	0.70	0.411
+ Plant parts.Stored	1	1.313	1.313	0.66	0.423
+ Plant parts.Stored.Season	1	2.302	2.302	1.16	0.292
Residual	24	47.506	1.979		
Total	31	74.407	2.400		

B2.2.3: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Plant parts		
Roots	14.87a	1.496
Shoots	12.94a	1.395

B2.2.4: Predictions from regression model – Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Stored		
Fresh	13.25a	1.426
Stored	14.56a	1.495

B2.2.5: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Season		
Summer	14.00a	1.492
Winter	13.81a	1.482

B2.2.6: Predictions from regression model - Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	**10.50b**	**1.597**	**16.00a**	**1.972**
Stored	**17.50a**	**2.063**	**11.63b**	**1.681**

B2.2.7: Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	15.75	1.967	14.00	1.855
Shoots	12.25	1.735	13.62	1.830

B2.2.8: Predictions from regression model – Plant parts and Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	14.75	1.917	11.75	1.710
Stored	15.00	1.933	14.13	1.875

B2.2.9: Predictions from regression model – Plant parts, Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Fresh	Summer	13.50	2.585	7.50	1.919
	Winter	16.00	2.814	16.00	2.814
Stored	Summer	18.00	2.985	17.00	2.900
	Winter	12.00	2.437	11.25	2.359

B2.3: GLM factorial analysis of Germination percentage

B2.3.1: Regression analysis

Response variate: Germination percentage
Binomial totals: Total
Distribution: Binomial
Link function: Logit
Fitted terms: Constant + Stored + Plant parts + Plant parts.Stored + Season + Plant parts.Season + Stored.Season + Plant parts.Stored.Season

B2.3.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Stored	**1**	**27.313**	**27.313**	**8.52**	**0.008**
+ Plant parts	**1**	**57.773**	**57.773**	**18.01**	**<.001**
+ Plant parts.Stored	1	1.501	1.501	0.47	0.500
+ Season	1	7.525	7.525	2.35	0.139
+ Plant parts.Season	1	0.341	0.341	0.11	0.747
+ Stored.Season	1	4.580	4.580	1.43	0.244
+ Plant parts.Stored.Season	1	0.311	0.311	0.10	0.758
Residual	24	76.979	3.207		
Total	31	176.322	5.688		

B2.3.3: Predictions from regression model - Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Stored		
Fresh	**0.0875b**	**0.02226**
Stored	**0.1750a**	**0.02994**

B2.3.4: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Plant parts		
Roots	**0.1938a**	**0.02448**
Shoots	**0.0688b**	**0.01579**

B2.3.5: Predictions from regression model – Plant parts and Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	0.1400	0.03106	0.0350	0.01643
Stored	0.2475	0.03863	0.1025	0.02715

B2.3.6: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Season		
Summer	0.1088a	0.01877
Winter	0.1538a	0.02157

B2.3.7: Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	0.1575	0.03206	0.2300	0.03694
Shoots	0.0600	0.02090	0.0775	0.02348

B2.3.8: Predictions from regression model - Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	0.0875	0.02446	0.0875	0.02434
Stored	0.1300	0.02925	0.2200	0.03542

B2.3.9: Predictions from regression model – Plant parts, Season and Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Fresh	Summer	0.1400	0.04394	0.0350	0.02325
	Winter	0.1400	0.04394	0.0350	0.02325
Stored	Summer	0.1750	0.04812	0.0850	0.03532
	Winter	0.3200	0.05907	0.1200	0.04115

B2.4: GLM factorial analysis of Radicle Length

B2.4.1: Regression analysis

Response variate: Radicle length
Distribution: Gamma
Link function: Reciprocal

Fitted terms: Constant + Stored + Plant parts + Plant parts.Stored + Season + Stored.Season + Plant parts.Season + Plant parts.Stored.Season

B2.4.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Stored	**1**	**1.3063**	**1.3063**	**8.63**	**0.007**
+ Plant parts	**1**	**1.2586**	**1.2586**	**8.32**	**0.008**
+ Plant parts.Stored	1	0.2936	0.2936	1.94	0.176
+ Season	1	0.0822	0.0822	0.54	0.468
+ Stored.Season	1	0.0384	0.0384	0.25	0.619
+ Plant parts.Season	1	0.2168	0.2168	1.43	0.243
+ Plant parts.Stored.Season	1	0.0867	0.0867	0.57	0.456
Residual	24	3.6309	0.1513		
Total	31	6.9135	0.2230		

B2.4.3: Predictions from regression model - Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Stored		
Fresh	**1.375b**	**0.7403**
Stored	**2.563a**	**0.6150**

B2.4.4: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Plant parts		
Roots	**2.563a**	**0.6462**
Shoots	**1.375b**	**0.7673**

B2.4.5: Predictions from regression model – Plant parts and Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	3.000	0.4036	1.750	0.2354
Stored	4.125	0.5550	3.000	0.4036

B2.4.6: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Season		
Summer	3.125a	0.3124
Winter	2.813a	0.2794

B2.4.7: Predictions from regression model - Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	2.375	0.3377	2.375	0.3377
Stored	3.875	0.5406	3.250	0.4516

B2.4.8: Predictions from regression model – Plant parts, Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Fresh	Summer	3.000	0.5834	1.750	0.3403
	Winter	3.000	0.5834	1.750	0.3403
Stored	Summer	5.000	0.9724	2.750	0.5348
	Winter	3.250	0.6320	3.250	0.6321

B3: *Eragrostis tef*

B3.1: GLM factorial analysis of Days to first germination

B3.1.1: Regression analysis

Response variate:	Days to first germination
Distribution:	Poisson
Link function:	Log

Fitted terms: Constant + Season + Stored + Stored.Season + Plant parts + Plant parts.Stored + Plant parts.Season + Plant parts.Stored.Season

B3.1.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx chi pr
+ Season	1	2.484E+00	2.484E+00	2.48	0.115
+ Stored	**1**	**6.147E+00**	**6.147E+00**	**6.15**	**0.013**
+ Stored.Season	1	2.134E-01	2.134E-01	0.21	0.644
+ Plant parts	1	5.063E-02	5.063E-02	0.05	0.822
+ Plant parts.Stored	1	3.826E-02	3.826E-02	0.04	0.845
+ Plant parts.Season	1	4.036E-02	4.036E-02	0.04	0.841
+ Plant parts.Stored.Season	1	3.079E-02	3.079E-02	0.03	0.861
Residual	24	8.882E-16	3.701E-17		
Total	31	9.004E+00	2.905E-01		

B3.1.3: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Season		
Summer	9.000a	0.7500
Winter	10.750a	0.8196

B3.1.4: Predictions from regression model - Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Stored		
Fresh	**11.250a**	**0.8385**
Stored	**8.500b**	**0.7289**

B3.1.5: Predictions from regression model - Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	10.000	1.118	12.500	1.250
Stored	8.000	1.000	9.000	1.061

B3.1.6: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Plant parts		
Roots	10.000a	0.7906
Shoots	9.750a	0.7806

B3.1.7: Predictions from regression model Plant parts and Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	11.500	1.199	11.000	1.173
Stored	8.500	1.031	8.500	1.031

B3.1.8: Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	9.000	1.061	11.000	1.173
Shoots	9.000	1.061	10.500	1.146

B3.1.9: Predictions from regression model Plant parts, Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Fresh	Summer	10.000	1.581	10.000	1.581
	Winter	13.000	1.803	12.000	1.732
Stored	Summer	8.000	1.414	8.000	1.414
	Winter	9.000	1.500	9.000	1.500

B3.2: GLM factorial analysis of Days to maximum germination

B3.2.1: Regression analysis

Response variate: Days to maximum germination
Distribution: Poisson
Link function: Log
Fitted terms: Constant + Season + Stored + Stored.Season + Plant parts + Plant parts.Stored + Plant parts.Season + Plant parts.Stored.Season

B3.2.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx chi pr
+ Season	1	1.776E-14	1.776E-14	0.00	1.000
+ Stored	1	1.941E+00	1.941E+00	1.94	0.164
+ Stored.Season	1	4.867E-01	4.867E-01	0.49	0.485
Residual	28	5.642E-12	2.015E-13		
+ Plant parts	1	-3.553E-15	-3.553E-15	0.00	*
+ Plant parts.Stored	1	-7.105E-15	-7.105E-15	0.00	*
+ Plant parts.Season	1	6.776E-21	6.776E-21	0.00	1.000
+ Plant parts.Stored.Season	1	0.000E+00	0.000E+00	0.00	1.000
Total	31	2.427E+00	7.830E-02		

Message: ratios are based on dispersion parameter with value 1.

B3.2.3: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Season		
Summer	16.50a	1.016
Winter	16.50a	1.016

B3.2.4: Predictions from regression model - Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Stored		
Fresh	15.50a	0.984
Stored	17.50a	1.046

B3.2.5: Predictions from regression model - Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	15.00	1.369	16.00	1.414
Stored	18.00	1.500	17.00	1.457

B3.2.6: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Plant parts		
Roots	16.50	1.015
Shoots	16.50	1.015

B3.2.7: Predictions from regression model – Plant parts and Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	15.50	1.392	15.50	1.392
Stored	17.50	1.479	17.50	1.479

B3.2.8: Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	16.50	1.436	16.50	1.436
Shoots	16.50	1.436	16.50	1.436

B3.2.9: Predictions from regression model – Plant parts, Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Fresh	Summer	15.00	1.936	15.00	1.936
	Winter	16.00	2.000	16.00	2.000
Stored	Summer	18.00	2.121	18.00	2.121
	Winter	17.00	2.061	17.00	2.061

B3.3: GLM factorial analysis of Germination percentage

B3.3.1: Regression analysis

Response variate: Germination percentage
Binomial totals: Total
Distribution: Binomial
Link function: Logit
Fitted terms: Constant + Stored + Season + Stored.Season + Plant parts + Plant parts.Season + Plant parts.Stored + Plant parts.Stored.Season

B3.3.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Stored	**1**	**37.065**	**37.065**	**7.99**	**0.009**
+ Season	**1**	**30.004**	**30.004**	**6.47**	**0.018**
+ Stored.Season	**1**	**22.600**	**22.600**	**4.87**	**0.037**
+ Plant parts	1	15.727	15.727	3.39	0.078
+ Plant parts.Season	1	1.131	1.131	0.24	0.626
+ Plant parts.Stored	1	0.003	0.003	0.00	0.980
+ Plant parts.Stored.Season	1	0.910	0.910	0.20	0.662
Residual	24	111.305	4.638		
Total	31	218.744	7.056		

B3.3.3: Predictions from regression model - Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Stored		
Fresh	**0.2125b**	**0.03558**
Stored	**0.3488a**	**0.04146**

B3.3.4: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Season		
Summer	**0.2200b**	**0.03313**
Winter	**0.3413a**	**0.03781**

B3.3.5: Predictions from regression model - Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.
Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	**0.2125b**	**0.04390**	**0.2125b**	**0.04390**
Stored	**0.2275b**	**0.04499**	**0.4700a**	**0.05358**

B3.3.6: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Plant parts		
Roots	0.3238a	0.03280
Shoots	0.2375a	0.02993

B3.3.7: Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	0.2475	0.04478	0.4000	0.04875
Shoots	0.1925	0.04095	0.2825	0.04515

B3.3.8: Predictions from regression model – Plant parts and Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	0.2500	0.04583	0.1750	0.04022
Stored	0.3975	0.04958	0.3000	0.04737

B3.3.9: Predictions from regression model – Plant parts, Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Fresh	Summer	0.2500	0.06591	0.1750	0.05785
	Winter	0.2500	0.06591	0.1750	0.05785
Stored	Summer	0.2450	0.06540	0.2100	0.06202
	Winter	0.5500	0.07576	0.3900	0.07427

B3.4: GLM factorial analysis of Radicle Length

B3.4.1: Regression analysis

Response variate: Radicle length
Distribution: Gamma
Link function: Reciprocal
Fitted terms: Constant + Stored + Season + Stored.Season + Plant parts + Plant parts.Stored + Plant parts.Season + Plant parts.Stored.Season

B3.4.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Stored	1	0.5303	0.5303	0.83	0.372
+ Season	1	0.1869	0.1869	0.29	0.594
+ Stored.Season	1	0.1135	0.1135	0.18	0.678
+ Plant parts	1	0.5162	0.5162	0.80	0.379
+ Plant parts.Stored	1	0.1204	0.1204	0.19	0.669
+ Plant parts.Season	1	0.0529	0.0529	0.08	0.776
+ Plant parts.Stored.Season	1	0.0315	0.0315	0.05	0.827
Residual	24	15.4038	0.6418		
Total	31	16.9555	0.5470		

B3.4.3: Predictions from regression model - Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Stored		
Fresh	2.125a	0.3911
Stored	2.750a	0.5072

B3.4.4: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Season		
Summer	2.625a	0.4940
Winter	2.250a	0.4222

B3.4.5: Predictions from regression model - Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	2.125	0.5673	2.125	0.5673
Stored	3.125	0.8364	2.375	0.6355

B3.4.6: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Plant parts		
Roots	2.125a	0.4074
Shoots	2.750a	0.5290

B3.4.7: Predictions from regression model – Plant parts and Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	1.750	0.4766	2.500	0.6781
Stored	2.500	0.6866	3.000	0.8240

B3.4.8: Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Season				
Summer	2.375	0.6765	2.875	0.8046
Winter	1.875	0.5231	2.625	0.7258

B3.4.9: Predictions from regression model – Plant parts, Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Fresh	Summer	1.750	0.6996	2.500	0.9954
	Winter	1.750	0.6996	2.500	0.9954
Stored	Summer	3.000	1.1999	3.250	1.2974
	Winter	2.000	0.8006	2.750	1.0974

B4: *Panicum maximum*

B4.1: GLM factorial analysis of Days to first germination

B4.1.1: Regression analysis

Response variate: Days to first germination
Distribution: Poisson
Link function: Log
Fitted terms: Constant + Plant parts + Season + Stored + Stored.Season + Plant parts.Season + Plant parts.Stored + Plant parts.Stored.Season

B4.1.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Plant parts	1	1.849	1.849	1.03	0.320
+ Season	1	0.175	0.175	0.10	0.758
+ Stored	1	0.011	0.011	0.01	0.938
+ Stored.Season	1	0.173	0.173	0.10	0.759
+ Plant parts.Season	1	0.001	0.001	0.00	0.982
+ Plant parts.Stored	1	1.878	1.878	1.05	0.316
Residual	25	44.878	1.795		
+ Plant parts.Stored.Season	1	0.000	0.000	0.00	*
Total	31	48.964	1.579		

B4.1.3: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Plant parts		
Roots	12.25a	1.097
Shoots	10.63a	1.021

B4.1.4: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Season		
Summer	11.19a	1.064
Winter	11.69a	1.087

B4.1.5: Predictions from regression model - Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.
Response variate: Days to first germination

	Prediction	s.e.
Stored		
Fresh	11.38	1.092
Stored	11.50	1.098

B4.1.6: Predictions from regression model - Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	11.38	1.569	11.38	1.569
Stored	11.00	1.543	12.00	1.612

B4.1.7: Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	12.00	1.642	12.50	1.676
Shoots	10.38	1.527	10.88	1.563

B4.1.8: Predictions from regression model – Plant parts and Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	13.00	1.708	9.75	1.479
Stored	11.50	1.606	11.50	1.606

B4.1.9: Predictions from regression model – Plant parts, Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Fresh	Summer	13.00	2.465	9.75	2.135
	Winter	13.00	2.465	9.75	2.135
Stored	Summer	11.00	2.268	11.00	2.268
	Winter	12.00	2.369	12.00	2.369

B4.2: GLM factorial analysis of Days to maximum germination

B4.2.1: Regression analysis

Response variate: Days to maximum germination
Distribution: Poisson
Link function: Log
Fitted terms: Constant + Plant parts + Stored + Plant parts.Stored + Season + Stored.Season + Plant parts.Season + Plant parts.Stored.Season

B4.2.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Plant parts	1	2.950	2.950	1.26	0.272
+ Stored	1	6.414	6.414	2.75	0.110
+ Plant parts.Stored	1	1.673	1.673	0.72	0.405
+ Season	1	0.073	0.073	0.03	0.861
+ Stored.Season	1	0.156	0.156	0.07	0.798
+ Plant parts.Season	1	0.100	0.100	0.04	0.837
+ Plant parts.Stored.Season	1	0.078	0.078	0.03	0.856
Residual	24	55.971	2.332		
Total	31	67.416	2.175		

B4.2.3: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Plant parts		
Roots	16.50a	1.489
Shoots	14.13a	1.377

B4.2.4: Predictions from regression model - Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Stored		
Fresh	13.56a	1.303
Stored	17.06a	1.461

B4.2.5: Predictions from regression model – Plant parts and Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	15.50	1.975	11.63	1.710
Stored	17.50	2.099	16.62	2.046

B4.2.6: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Season		
Summer	15.13a	1.404
Winter	15.50a	1.421

B4.2.7: Predictions from regression model - Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	13.13	1.882	14.00	1.944
Stored	17.12	2.150	17.00	2.142

B4.2.8: Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	16.50	2.150	16.50	2.150
Shoots	13.75	1.963	14.50	2.016

B4.2.9: Predictions from regression model – Plant parts, Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Fresh	Summer	15.00	2.957	11.25	2.561
	Winter	16.00	3.054	12.00	2.645
Stored	Summer	18.00	3.240	16.25	3.078
	Winter	17.00	3.148	17.00	3.148

B4.3: GLM factorial analysis of Germination percentage

B4.3.1: Regression analysis

Response variate: Germination percentage
Binomial totals: Total
Distribution: Binomial
Link function: Logit
Fitted terms: Constant + Stored + Season + Stored.Season + Plant parts + Plant parts.Season + Plant parts.Stored + Plant parts.Stored.Season

B4.3.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Stored	**1**	**23.847**	**23.847**	**8.42**	**0.008**
+ Season	**1**	**16.253**	**16.253**	**5.74**	**0.025**
+ Stored.Season	1	11.431	11.431	4.04	0.056
+ Plant parts	1	3.161	3.161	1.12	0.301
+ Plant parts.Season	1	0.011	0.011	0.00	0.951
+ Plant parts.Stored	1	0.051	0.051	0.02	0.894
+ Plant parts.Stored.Season	1	0.012	0.012	0.00	0.948
Residual	24	67.979	2.832		
Total	31	122.746	3.960		

B4.3.3: Predictions from regression model - Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Stored		
Fresh	**0.1525b**	**0.02304**
Stored	**0.2500a**	**0.02779**

B4.3.4: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Season		
Summer	**0.1613b**	**0.02177**
Winter	**0.2413a**	**0.02530**

B4.3.5: Predictions from regression model - Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	0.1525	0.02862	0.1525	0.02862
Stored	0.1700	0.02993	0.3300	0.03749

B4.3.6: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Plant parts		
Roots	0.2188a	0.02278
Shoots	0.1838a	0.02138

B4.3.7: Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Plant parts				
Roots	0.1775	0.03090	0.2600	0.03466
Shoots	0.1450	0.02847	0.2225	0.03295

B4.3.8: Predictions from regression model – Plant parts and Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	0.1650	0.03061	0.1400	0.02861
Stored	0.2725	0.03606	0.2275	0.03399

B4.3.9: Predictions from regression model – Plant parts, Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Fresh	Summer	0.1650	0.04417	0.1400	0.04129
	Winter	0.1650	0.04417	0.1400	0.04129
Stored	Summer	0.1900	0.04669	0.1500	0.04249
	Winter	0.3550	0.05695	0.3050	0.05479

B4.4 GLM factorial analysis of Radicle Length

B4.4.1: Regression analysis

Response variate: Radicle length
Distribution: Gamma
Link function: Reciprocal
Fitted terms: Constant + Stored + Season + Stored.Season + Plant parts + Plant parts.Stored + Plant parts.Season + Plant parts.Stored.Season

B4.4.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Stored	1	0.5800	0.5800	3.46	0.075
+ Season	1	0.1642	0.1642	0.98	0.332
+ Stored.Season	1	0.0971	0.0971	0.58	0.454
+ Plant parts	1	0.4030	0.4030	2.41	0.134
+ Plant parts.Stored	1	0.0576	0.0576	0.34	0.563
+ Plant parts.Season	1	0.0505	0.0505	0.30	0.588
+ Plant parts.Stored.Season	1	0.0297	0.0297	0.18	0.677
Residual	24	4.0195	0.1675		
Total	31	5.4015	0.1742		

B4.4.3: Predictions from regression model - Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Stored		
Fresh	1.625a	0.7369
Stored	2.438a	0.6555

B4.4.4: Predictions from regression model – Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Season		
Summer	2.250	0.6722
Winter	1.813	0.7161

B4.4.5: Predictions from regression model - Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	1.625	0.6255	1.625	0.6255
Stored	2.875	0.4471	2.000	0.5720

B4.4.6: Predictions from regression model – Plant parts

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Plant parts		
Roots	2.375	0.6632
Shoots	1.688	0.7336

B4.4.7: Predictions from regression model – Plant parts and Stored plant material

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Stored				
Fresh	2.000	0.5788	1.250	0.7371
Stored	2.750	0.4686	1.125	0.5584

B4.4.8: Predictions from regression model – Plant parts and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Plant parts	Roots		Shoots	
	Prediction	s.e.	Prediction	s.e.
Season				
Summer	2.750	0.4582	1.750	0.5999
Winter	2.000	0.5730	1.625	0.6243

B4.4.9: Predictions from regression model – Plant parts, Stored plant material and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Plant parts	Roots		Shoots	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Fresh	Summer	2.000	0.3862	1.250	0.5396
	Winter	2.000	0.3862	1.250	0.5396
Stored	Summer	3.500	0.0792	2.250	0.3350

Annexure C – Data analysis for soils as an allelopathic agent

C1: *Lactuca sativa*

C1.1: GLM factorial analysis of days to first germination

No significant difference occurred

C1.2: GLM factorial analysis of Days to maximum germination

C1.2.1: Regression analysis

Response variate: Days to maximum germination
Distribution: Poisson
Link function: Log
Fitted terms: Constant + Infested + Season + Infested.Season + Stored + Stored.Season + Infested.Stored + Infested.Stored.Season

C1.2.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx chi pr
+ Infested	1	0.000E+00	0.000E+00	0.00	1.000
+ Season	1	2.988E+00	2.988E+00	2.99	0.084
+ Infested.Season	1	1.922E+00	1.922E+00	1.92	0.166
+ Stored	1	4.777E-01	4.777E-01	0.48	0.489
+ Stored.Season	1	5.553E-01	5.553E-01	0.56	0.456
+ Infested.Stored	1	1.176E+00	1.176E+00	1.18	0.278
+ Infested.Stored.Season	1	1.378E+00	1.378E+00	1.38	0.240
Residual	24	8.783E-12	3.660E-13		
Total	31	8.497E+00	2.741E-01		

Message: ratios are based on dispersion parameter with value 1.

C1.2.3: Predictions from regression model – Infested soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Infested		
Control	16.75a	1.023
Infested	16.75a	1.023

C1.2.4: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Season		
Summer	18.00a	1.061
Winter	15.50a	0.984

C1.2.5: Predictions from regression model - Infested soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infested				
Control	17.00	1.458	16.50	1.436
Infested	19.00	1.541	14.50	1.346

C1.2.6: Predictions from regression model – Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Stored		
Immediately	16.25a	1.008
Stored	17.25a	1.038

C1.2.7: Predictions from regression model – Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	18.00	1.500	14.50	1.346
Stored	18.00	1.500	16.50	1.436

C1.2.8: Predictions from regression model – Infested soils and Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Infested	Control		Infested	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	17.00	1.458	15.50	1.392
Stored	16.50	1.436	18.00	1.500

C1.2.9: Predictions from regression model – Infested soils, Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Infested	Control		Infested	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Immediately	Summer	17.00	2.061	19.00	2.179
	Winter	17.00	2.061	12.00	1.731
Stored	Summer	17.00	2.061	19.00	2.179
	Winter	16.00	2.000	17.00	2.061

C1.3: GLM factorial analysis of Germination percentage

C1.3.1: Regression analysis

Response variate:	Germination percentage
Binomial totals:	Total
Distribution:	Binomial
Link function:	Logit

Fitted terms: Constant + Infested + Season + Infested.Season + Stored + Stored.Season + Infested.Stored + Infested.Stored.Season

C1.3.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Infested	**1**	**35.956**	**35.956**	**10.31**	**0.004**
+ Season	**1**	**26.308**	**26.308**	**7.54**	**0.011**
+ Infested.Season	1	6.659	6.659	1.91	0.180
+ Stored	**1**	**46.474**	**46.474**	**13.33**	**0.001**
+ Stored.Season	**1**	**62.497**	**62.497**	**17.92**	**<.001**
+ Infested.Stored	**1**	**29.588**	**29.588**	**8.48**	**0.008**
+ Infested.Stored.Season	**1**	**17.978**	**17.978**	**5.16**	**0.032**
Residual	24	83.694	3.487		
Total	31	309.155	9.973		

C1.3.3: Predictions from regression model – Infested soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Infested	Prediction	s.e.
Control	**0.7794a**	**0.04946**
Infested	**0.6269b**	**0.05769**

C1.3.4: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Prediction	s.e.
Summer	**0.7675a**	**0.04812**
Winter	**0.6387b**	**0.05450**

C1.3.5: Predictions from regression model – Infested soils and Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infested				
Control	0.8650	0.05595	0.6937	0.07547
Infested	0.6700	0.07699	0.5838	0.08071

C1.3.6: Predictions from regression model - Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Stored		
Immediately	**0.6187b**	**0.04976**
Stored	**0.7875a**	**0.04244**

C1.3.7: Predictions from regression model - Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	**0.7900a**	**0.04988**	**0.4475b**	**0.06183**
Stored	**0.7450a**	**0.05315**	**0.8300a**	**0.04688**

C1.3.8: Predictions from regression model – Infested soils and Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Infested	Control		Infested	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	**0.6387b**	**0.05006**	**0.5987b**	**0.05225**
Stored	**0.9200a**	**0.03047**	**0.6550b**	**0.05295**

C1.3.9: Predictions from regression model - Infested soils, Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Stored	Season	Control Prediction	s.e.	Infested Prediction	s.e.
Immediately	**Summer**	**0.8650ab**	**0.05045**	**0.7150b**	**0.06664**
	Winter	**0.4125c**	**0.07268**	**0.4825bc**	**0.07377**
Stored	**Summer**	**0.8650ab**	**0.05045**	**0.6250b**	**0.07147**
	Winter	**0.9750a**	**0.02303**	**0.6850b**	**0.06858**

C1.4: GLM factorial analysis of Radicle Length

C1.4.1: Regression analysis

Response variate: Radicle length
Distribution: Gamma
Link function: Reciprocal
Fitted terms: Constant + Infested + Season + Infested.Season + Stored + Stored.Season + Infested.Stored + Infested.Stored.Season

C1.4.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Infested	**1**	**20.9150**	**20.9150**	**59.00**	**<.001**
+ Season	1	1.1228	1.1228	3.17	0.088
+ Infested.Season	1	0.6518	0.6518	1.84	0.188
+ Stored	1	1.4744	1.4744	4.16	0.053
+ Stored.Season	**1**	**6.7032**	**6.7032**	**18.91**	**<.001**
+ Infested.Stored	1	0.3975	0.3975	1.12	0.300
+ Infested.Stored.Season	1	0.4870	0.4870	1.37	0.253
Residual	24	8.5079	0.3545		
Total	31	40.2596	1.2987		

C1.4.3: Predictions from regression model – Infested soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Infested	Prediction	s.e.
Control	**21.00a**	**4.213**
Infested	**3.81b**	**0.764**

C1.4.4: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Season		
Summer	15.19a	3.738
Winter	9.63a	2.228

C1.4.5: Predictions from regression model – Infested soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infested				
Control	27.13	7.597	14.88	4.136
Infested	3.25	0.908	4.38	1.224

C1.4.6: Predictions from regression model – Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Stored		
Immediately	9.13	2.096
Stored	15.69	3.982

C1.4.7: Predictions from regression model - Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	**15.13a**	**4.086**	**3.13b**	**0.671**
Stored	**15.25a**	**4.123**	**16.13a**	**4.023**

C1.4.8: Predictions from regression model – Infested soils and Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Infested	Control Prediction	s.e.	Infested Prediction	s.e.
Stored				
Immediately	14.88	4.000	3.38	0.718
Stored	27.13	5.754	4.25	0.957

C1.4.9: Predictions from regression model – Infested soils, Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Infested	Control Prediction	s.e.	Infested Prediction	s.e.
Stored	Season				
Immediately	Summer	27.00	8.038	3.25	0.964
	Winter	2.75	0.815	3.50	1.039
Stored	Summer	27.25	8.112	3.25	0.965
	Winter	27.00	8.038	5.25	1.563

C2: *Eragrostis curvula*

C2.1: GLM factorial analysis of Days to first germination

No significant difference occurred

C2.2: GLM factorial analysis of Days to maximum germination

C2.2.1: Regression analysis

Response variate: Days to maximum germination
Distribution: Poisson
Link function: Log
Fitted terms: Constant + Infested + Season + Infested.Season + Stored + Stored.Season + Infested.Stored + Infested.Stored.Season

C2.2.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx chi pr
+ Infested	1	2.837E-02	2.837E-02	0.03	0.866
+ Season	1	2.553E-01	2.553E-01	0.26	0.613
+ Infested.Season	1	2.960E-02	2.960E-02	0.03	0.863
+ Stored	1	2.553E-01	2.553E-01	0.26	0.613
+ Stored.Season	1	2.489E-02	2.489E-02	0.02	0.875
+ Infested.Stored	1	2.530E-01	2.530E-01	0.25	0.615
+ Infested.Stored.Season	1	2.572E-02	2.572E-02	0.03	0.873
Residual	24	3.303E-12	1.376E-13		
Total	31	8.723E-01	2.814E-02		

Message: ratios are based on dispersion parameter with value 1.

C2.2.3: Predictions from regression model – Infested soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Infested		
Control	17.50a	1.046
Infested	17.75a	1.053

C2.2.4: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Season		
Summer	18.00a	1.061
Winter	17.25a	1.038

C2.2.5: Predictions from regression model – Infested soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infested				
Control	18.00	1.500	17.00	1.458
Infested	18.00	1.500	17.50	1.479

C2.2.6: Predictions from regression model - Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Stored		
Immediately	17.25a	1.038
Stored	18.00a	1.061

C2.2.7: Predictions from regression model - Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	17.50	1.479	17.00	1.458
Stored	18.50	1.521	17.50	1.479

C2.2.8: Predictions from regression model – Infested soils and Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Infested	Control		Infested	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	17.50	1.479	17.00	1.458
Stored	17.50	1.479	18.50	1.521

C2.2.9: Predictions from regression model – Infested soils, Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Infested	Control		Infested	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Immediately	Summer	18.00	2.121	17.00	2.061
	Winter	17.00	2.061	17.00	2.061
Stored	Summer	18.00	2.121	19.00	2.179
	Winter	17.00	2.061	18.00	2.121

C2.3: GLM factorial analysis of Germination percentage

C2.3.1: Regression analysis

Response variate: Germination percentage
Binomial totals: Total
Distribution: Binomial
Link function: Logit
Fitted terms: Constant + Infested + Season + Infested.Season + Stored + Stored.Season + Infested.Stored + Infested.Stored.Season

C2.3.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Infested	**1**	**235.983**	**235.983**	**104.29**	**<.001**
+ Season	1	5.738	5.738	2.54	0.124
+ Infested.Season	**1**	**38.006**	**38.006**	**16.80**	**<.001**
+ Stored	1	0.019	0.019	0.01	0.927
+ Stored.Season	**1**	**31.313**	**31.313**	**13.84**	**0.001**
+ Infested.Stored	**1**	**11.194**	**11.194**	**4.95**	**0.036**
+ Infested.Stored.Season	1	0.015	0.015	0.01	0.936
Residual	24	54.305	2.263		
Total	31	376.573	12.148		

C2.3.3: Predictions from regression model – Infested soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Infested		
Control	**0.9100b**	**0.02443**
Infested	**0.5394a**	**0.04265**

C2.3.4: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Season		
Summer	0.6975a	0.03527
Winter	0.7519a	0.03377

C2.3.5: Predictions from regression model – Infested soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infested				
Control	**0.8400b**	**0.03811**	**0.9800a**	**0.01454**
Infested	**0.5550c**	**0.05167**	**0.5237c**	**0.05192**

C2.3.6: Predictions from regression model - Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Stored		
Immediately	0.7231a	0.03022
Stored	0.7262a	0.03015

C2.3.7: Predictions from regression model - Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	**0.7575b**	**0.03639**	**0.6887b**	**0.03255**
Stored	**0.6375c**	**0.04021**	**0.8150a**	**0.03081**

C2.3.8: Predictions from regression model – Infested soils and Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Infested	Control		Infested	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	**0.8975b**	**0.02437**	**0.5487c**	**0.03945**
Stored	**0.9225a**	**0.02119**	**0.5300c**	**0.04022**

C2.3.9: Predictions from regression model – Infested soils, Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Infested	Control Prediction	s.e.	Infested Prediction	s.e.
Stored	Season				
Immediately	**Summer**	**0.8300**	**0.04467**	**0.6850**	**0.05524**
	Winter	**0.9650**	**0.02186**	**0.4125**	**0.05854**
Stored	**Summer**	**0.8500**	**0.04246**	**0.4250**	**0.05879**
	Winter	**0.9950**	**0.00837**	**0.6350**	**0.05725**

C2.4: GLM factorial analysis of Radicle Length

C2.4.1: Regression analysis

Response variate: Radicle length
Distribution: Gamma
Link function: Reciprocal
Fitted terms: Constant + Infested + Stored + Infested.Stored + Season + Stored.Season + Infested.Season + Infested.Stored.Season

C2.4.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Infested	**1**	**14.6685**	**14.6685**	**79.25**	**<.001**
+ Stored	1	0.0424	0.0424	0.23	0.636
+ Infested.Stored	1	0.0262	0.0262	0.14	0.710
+ Season	1	0.0238	0.0238	0.13	0.723
+ Stored.Season	1	0.0012	0.0012	0.01	0.936
+ Infested.Season	1	0.0890	0.0890	0.48	0.495
+ Infested.Stored.Season	1	0.1097	0.1097	0.59	0.449
Residual	24	4.4424	0.1851		
Total	31	19.4032	0.6259		

C2.4.3: Predictions from regression model – Infested soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Infested		
Control	**9.438a**	**0.9373**
Infested	**2.313b**	**0.2296**

C2.4.4: Predictions from regression model - Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Stored		
Immediately	5.625a	0.6579
Stored	6.125a	0.7240

C2.4.5: Predictions from regression model – Infested soils and Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Infested	Control		Infested	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	8.875	1.2809	2.375	0.3426
Stored	10.000	1.4433	2.250	0.3246

C2.4.6: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Season		
Summer	5.688a	0.6878
Winter	6.063a	0.7391

C2.4.7: Predictions from regression model - Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	5.500	0.946	5.750	0.995
Stored	5.875	1.033	6.375	1.132

C2.4.8: Predictions from regression model – Infested soils, Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Infested	Control Prediction	s.e.	Infested Prediction	s.e.
Stored	Season				
Immediately	Summer	9.000	1.936	2.000	0.430
	Winter	8.750	1.882	2.750	0.591
Stored	Summer	9.500	2.044	2.250	0.484
	Winter	10.500	2.259	2.250	0.484

C3: *Eragrostis tef*

C3.1: GLM factorial analysis of Days to first germination

C3.1.1: Regression analysis

Response variate: Days to first germination
Distribution: Poisson
Link function: Log
Fitted terms: Constant + Infested + Season + Infested.Season + Stored + Stored.Season + Infested.Stored + Infested.Stored.Season

C3.1.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx chi pr
+ Infested	1	7.273E-02	7.273E-02	0.07	0.787
+ Season	1	7.273E-02	7.273E-02	0.07	0.787
+ Infested.Season	1	7.545E-02	7.545E-02	0.08	0.784
+ Stored	1	7.273E-02	7.273E-02	0.07	0.787
+ Stored.Season	1	7.545E-02	7.545E-02	0.08	0.784
+ Infested.Stored	1	7.833E-02	7.833E-02	0.08	0.780
+ Infested.Stored.Season	1	8.149E-02	8.149E-02	0.08	0.775
Residual	24	1.776E-15	7.401E-17		
Total	31	5.289E-01	1.706E-02		

Message: ratios are based on dispersion parameter with value 1.

C3.1.3: Predictions from regression model – Infested soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Infested		
Control	6.750	0.6495
Infested	7.000	0.6614

C3.1.4: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Season		
Summer	6.750a	0.6495
Winter	7.000a	0.6614

C3.1.5: Predictions from regression model – Infested soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infested				
Control	6.500	0.9014	7.000	0.9354
Infested	7.000	0.9354	7.000	0.9354

C3.1.6: Predictions from regression model - Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Stored		
Immediately	6.750a	0.6495
Stored	7.000a	0.6614

C3.1.7: Predictions from regression model - Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	6.500	0.9014	7.000	0.9354
Stored	7.000	0.9354	7.000	0.9354

C3.1.8: Predictions from regression model – Infested soils and Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Infested	Control Prediction	s.e.	Infested Prediction	s.e.
Stored				
Immediately	6.500	0.9014	7.000	0.9354
Stored	7.000	0.9354	7.000	0.9354

C3.1.9: Predictions from regression model – Infested soils, Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Infested	Control Prediction	s.e.	Infested Prediction	s.e.
Stored	Season				
Immediately	Summer	6.000	1.225	7.000	1.323
	Winter	7.000	1.323	7.000	1.323
Stored	Summer	7.000	1.323	7.000	1.323
	Winter	7.000	1.323	7.000	1.323

C3.2: GLM factorial analysis of Days to maximum germination

C3.2.1: Regression analysis

Response variate: Days to maximum germination
Distribution: Poisson
Link function: Log
Fitted terms: Constant + Infested + Season + Infested.Season + Stored + Stored.Season + Infested.Stored + Infested.Stored.Season

C3.2.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx chi pr
+ Infested	1	2.553E-01	2.553E-01	0.26	0.613
+ Season	1	2.553E-01	2.553E-01	0.26	0.613
+ Infested.Season	1	6.920E-01	6.920E-01	0.69	0.405
+ Stored	1	2.837E-02	2.837E-02	0.03	0.866
+ Stored.Season	1	2.960E-02	2.960E-02	0.03	0.863
+ Infested.Stored	1	2.760E-02	2.760E-02	0.03	0.868
+ Infested.Stored.Season	1	2.873E-02	2.873E-02	0.03	0.865
Residual	24	3.354E-12	1.398E-13		
Total	31	1.317E+00	4.248E-02		

Message: ratios are based on dispersion parameter with value 1.

C3.2.3: Predictions from regression model – Infested soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Infested		
Control	17.25a	1.038
Infested	18.00a	1.061

C3.2.4: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Season		
Summer	18.00a	1.061
Winter	17.25a	1.038

C3.2.5: Predictions from regression model – Infested soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infested				
Control	17.00	1.458	17.50	1.479
Infested	19.00	1.541	17.00	1.458

C3.2.6: Predictions from regression model - Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Stored		
Immediately	17.50a	1.046
Stored	17.75a	1.053

C3.2.7: Predictions from regression model - Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	18.00	1.500	17.00	1.458
Stored	18.00	1.500	17.50	1.479

C3.2.8: Predictions from regression model – Infested soils and Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Infested	Control		Infested	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	17.00	1.458	18.00	1.500
Stored	17.50	1.479	18.00	1.500

C3.2.9: Predictions from regression model – Infested soils, Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Infested	Control		Infested	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Immediately	Summer	17.00	2.061	19.00	2.179
	Winter	17.00	2.061	17.00	2.061
Stored	Summer	17.00	2.061	19.00	2.179
	Winter	18.00	2.121	17.00	2.061

C3.3: GLM factorial analysis of Germination percentage

C3.3.1: Regression analysis

Response variate: Germination percentage
Binomial totals: Total
Distribution: Binomial
Link function: Logit
Fitted terms: Constant + Infested + Season + Infested.Season + Stored + Stored.Season + Infested.Stored + Infested.Stored.Season

C3.3.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx chi pr
+ Infested	**1**	**212.011**	**212.011**	**212.01**	**<.001**
+ Season	**1**	**54.134**	**54.134**	**54.13**	**<.001**
+ Infested.Season	**1**	**50.040**	**50.040**	**50.04**	**<.001**
+ Stored	**1**	**13.882**	**13.882**	**13.88**	**<.001**
+ Stored.Season	**1**	**18.511**	**18.511**	**18.51**	**<.001**
+ Infested.Stored	**1**	**16.186**	**16.186**	**16.19**	**<.001**
+ Infested.Stored.Season	**1**	**18.976**	**18.976**	**18.98**	**<.001**
Residual	24	25.229	1.051		
Total	31	408.971	13.193		

Message: ratios are based on dispersion parameter with value 1.

C3.3.3: Predictions from regression model – Infested soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Infested		
Control	**0.8981a**	**0.01195**
Infested	**0.5438b**	**0.01969**

C3.3.4: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Season		
Summer	**0.8050a**	**0.01469**
Winter	**0.6369b**	**0.01695**

C3.3.5: Predictions from regression model – Infested soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infested				
Control	**0.8725b**	**0.01864**	**0.9237a**	**0.01483**
Infested	**0.7375c**	**0.02460**	**0.3500d**	**0.02666**

C3.3.6: Predictions from regression model - Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Stored		
Immediately	**0.6806b**	**0.01580**
Stored	**0.7612a**	**0.01467**

C3.3.7: Predictions from regression model - Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	**0.8100a**	**0.02162**	**0.5512b**	**0.02059**
Stored	**0.8000a**	**0.02203**	**0.7225a**	**0.02112**

C3.3.8: Predictions from regression model – Infested soils and Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Infested	Control		Infested	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	**0.9187a**	**0.01526**	**0.4425c**	**0.02378**
Stored	**0.8775a**	**0.01808**	**0.6450b**	**0.02572**

C3.3.9: Predictions from regression model – Infested soils, Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Infested	Control		Infested	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Immediately	**Summer**	**0.8800b**	**0.02569**	**0.7400c**	**0.03468**
	Winter	**0.9575a**	**0.01591**	**0.1450e**	**0.02784**
Stored	**Summer**	**0.8650b**	**0.02701**	**0.7350c**	**0.03489**
	Winter	**0.8900b**	**0.02473**	**0.5550d**	**0.03929**

C.3.4: GLM factorial analysis of Radicle Length

C3.4.1: Regression analysis

Response variate: Radicle length
Distribution: Gamma
Link function: Reciprocal
Fitted terms: Constant + Infested + Season + Infested.Season + Stored + Stored.Season + Infested.Stored + Infested.Stored.Season

C3.4.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ Infested	**1**	**10.64277**	**10.64277**	**107.23**	**<.001**
+ Season	1	0.10190	0.10190	1.03	0.321
+ Infested.Season	1	0.37693	0.37693	3.80	0.063
+ Stored	1	0.02781	0.02781	0.28	0.601
+ Stored.Season	1	0.00824	0.00824	0.08	0.776
+ Infested.Stored	**1**	**0.77523**	**0.77523**	**7.81**	**0.010**
+ Infested.Stored.Season	**1**	**0.94340**	**0.94340**	**9.51**	**0.005**
Residual	24	2.38201	0.09925		
Total	31	15.25828	0.49220		

C3.4.3: Predictions from regression model – Infested soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Infested		
Control	**15.75a**	**1.544**
Infested	**4.81b**	**0.472**

C3.4.4: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Season		
Summer	10.94a	1.231
Winter	9.63a	1.066

C3.4.5: Predictions from regression model – Infested soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infested				
Control	16.25	2.208	15.25	2.072
Infested	5.63	0.764	4.00	0.543

C3.4.6: Predictions from regression model - Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Stored		
Immediately	10.63a	1.180
Stored	9.94a	1.095

C3.4.7: Predictions from regression model - Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	11.13	1.740	10.13	1.657
Stored	10.75	1.675	9.13	1.474

C3.4.8: Predictions from regression model – Infested soils and Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Infested	Control		Infested	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	**15.38a**	**1.983**	**5.88b**	**0.771**
Stored	**16.13a**	**2.084**	**3.75c**	**0.488**

C3.4.9: Predictions from regression model – Infested soils, Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Infested	Control Prediction	s.e.	Infested Prediction	s.e.
Stored	Season				
Immediately	**Summer**	**16.25a**	**2.560**	**6.00b**	**0.945**
	Winter	**14.50a**	**2.284**	**5.75b**	**0.906**
Stored	**Summer**	**16.25a**	**2.560**	**5.25b**	**0.827**
	Winter	**16.00a**	**2.520**	**2.25c**	**0.353**

C4: *Panicum maximum*

C4.1: GLM factorial analysis of Days to first germination

C4.1.1: Regression analysis

Response variate: Days to first germination
Distribution: Poisson
Link function: Log
Fitted terms: Constant + Infested + Season + Infested.Season + Stored + Stored.Season + Infested.Stored + Infested.Stored.Season

C4.1.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx chi pr
+ Infested	**1**	**4.2451**	**4.2451**	**4.25**	**0.039**
+ Season	1	0.1365	0.1365	0.14	0.712
+ Infested.Season	1	1.8734	1.8734	1.87	0.171
+ Stored	1	0.1365	0.1365	0.14	0.712
+ Stored.Season	1	0.1313	0.1313	0.13	0.717
+ Infested.Stored	1	0.1285	0.1285	0.13	0.720
+ Infested.Stored.Season	1	0.1199	0.1199	0.12	0.729
Residual	24	2.6703	0.1113		
Total	31	9.4415	0.3046		

Message: ratios are based on dispersion parameter with value 1.

C4.1.3: Predictions from regression model – Infested soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Infested		
Control	**10.00b**	**0.7906**
Infested	**12.44a**	**0.8817**

C4.1.4: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Season		
Summer	11.00a	0.8292
Winter	11.44a	0.8455

C4.1.5: Predictions from regression model – Infested soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.
Response variate: Days to first germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infested				
Control	9.00	1.061	11.00	1.173
Infested	13.00	1.275	11.88	1.218

C4.1.6: Predictions from regression model - Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Prediction	s.e.
Stored		
Immediately	11.44	0.8455
Stored	11.00	0.8291

C4.1.7: Predictions from regression model - Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	11.00	1.173	11.88	1.218
Stored	11.00	1.173	11.00	1.173

C4.1.8: Predictions from regression model – Infested soils and Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

Infested	Control Prediction	s.e.	Infested Prediction	s.e.
Stored				
Immediately	10.00	1.118	12.88	1.269
Stored	10.00	1.118	12.00	1.225

C4.1.9: Predictions from regression model – Infested soils, Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to first germination

	Infested	Control Prediction	s.e.	Infested Prediction	s.e.
Stored	Season				
Immediately	Summer	9.00	1.500	13.00	1.803
	Winter	11.00	1.658	12.75	1.785
Stored	Summer	9.00	1.500	13.00	1.803
	Winter	11.00	1.658	11.00	1.658

C4.2: GLM factorial analysis of Days to maximum germination

C4.2.1: Regression analysis

Response variate: Days to maximum germination
Distribution: Poisson
Link function: Log
Fitted terms: Constant + Infested + Season + Infested.Season + Stored + Stored.Season + Infested.Stored + Infested.Stored.Season

C4.2.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx chi pr
+ Infested	1	2.759E-02	2.759E-02	0.03	0.868
+ Season	1	2.483E-01	2.483E-01	0.25	0.618
+ Infested.Season	1	2.450E-01	2.450E-01	0.24	0.621
+ Stored	1	2.759E-02	2.759E-02	0.03	0.868
+ Stored.Season	1	2.875E-02	2.875E-02	0.03	0.865
+ Infested.Stored	1	2.839E-02	2.839E-02	0.03	0.866
+ Infested.Stored.Season	1	2.958E-02	2.958E-02	0.03	0.863
Residual	24	2.700E-12	1.125E-13		
Total	31	6.352E-01	2.049E-02		

Message: ratios are based on dispersion parameter with value 1.

C4.2.3: Predictions from regression model – Infested soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Infested		
Control	18.25a	1.068
Infested	18.00a	1.061

C4.2.4: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Season		
Summer	18.50a	1.075
Winter	17.75a	1.053

C4.2.5: Predictions from regression model – infested and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infested				
Control	19.00	1.541	17.50	1.479
Infested	18.00	1.500	18.00	1.500

C4.2.6: Predictions from regression model - Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Prediction	s.e.
Stored		
Immediately	18.00	1.061
Stored	18.25	1.068

C4.2.7: Predictions from regression model - Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	18.50	1.521	17.50	1.479
Stored	18.50	1.521	18.00	1.500

C4.2.8: Predictions from regression model – Infested soils and Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

Infested	Control		Infested	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	18.00	1.500	18.00	1.500
Stored	18.50	1.521	18.00	1.500

C4.2.9: Predictions from regression model – Infested soils, Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Days to maximum germination

	Infested	Control		Infested	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Immediately	Summer	19.00	2.179	18.00	2.121
	Winter	17.00	2.061	18.00	2.121
Stored	Summer	19.00	2.179	18.00	2.121
	Winter	18.00	2.121	18.00	2.121

C4.3: GLM factorial analysis of Germination percentage

C4.3.1: Regression analysis

Response variate: Germination percentage
Binomial totals: Total
Distribution: Binomial
Link function: Logit
Fitted terms: Constant + Infested + Season + Infested.Season + Stored + Stored.Season + Infested.Stored + Infested.Stored.Season

C4.3.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx chi pr
+ Infested	**1**	**373.112**	**373.112**	**373.11**	**<.001**
+ Season	**1**	**11.818**	**11.818**	**11.82**	**<.001**
+ Infested.Season	**1**	**25.954**	**25.954**	**25.95**	**<.001**
+ Stored	1	0.348	0.348	0.35	0.555
+ Stored.Season	1	2.487	2.487	2.49	0.115
+ Infested.Stored	**1**	**9.950**	**9.950**	**9.95**	**0.002**
+ Infested.Stored.Season	**1**	**10.813**	**10.813**	**10.81**	**0.001**
Residual	24	24.086	1.004		
Total	31	458.568	14.793		

Message: ratios are based on dispersion parameter with value 1.

C4.3.3: Predictions from regression model – Infested soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Infested		
Control	**0.8062a**	**0.01562**
Infested	**0.2825b**	**0.01780**

C4.3.4: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Season		
Summer	**0.5850a**	**0.01663**
Winter	**0.5037b**	**0.01670**

C4.3.5: Predictions from regression model – Infested soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infested				
Control	**0.7825a**	**0.02306**	**0.8300a**	**0.02100**
Infested	**0.3875b**	**0.02723**	**0.1775c**	**0.02136**

C4.3.6: Predictions from regression model - Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Prediction	s.e.
Stored		
Immediately	0.5512a	0.01645
Stored	0.5375a	0.01649

C4.3.7: Predictions from regression model - Stored soils ans Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	0.5750	0.02529	0.5275	0.02114
Stored	0.5950	0.02516	0.4800	0.02113

C4.3.8: Predictions from regression model – Infested soils and Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

Infested	Control		Infested	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	**0.8500a**	**0.01987**	**0.2525c**	**0.02386**
Stored	**0.7625b**	**0.02378**	**0.3125c**	**0.02489**

C4.3.9: Predictions from regression model – Infested soils, Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Germination percentage

	Infested	Control		Infested	
		Prediction	s.e.	Prediction	s.e.
Stored	Season				
Immediately	**Summer**	**0.7800b**	**0.03275**	**0.3700d**	**0.03817**
	Winter	**0.9200a**	**0.02144**	**0.1350e**	**0.02702**
Stored	**Summer**	**0.7850b**	**0.03248**	**0.4050d**	**0.03881**
	Winter	**0.7400c**	**0.03468**	**0.2200e**	**0.03275**

C4.4: GLM factorial analysis of Radicle Length

C4.4.1: Regression analysis

Response variate: Radicle length
Distribution: Gamma
Link function: Reciprocal
Fitted terms: Constant + Infested + Season + Infested.Season + Stored + Stored.Season + Infested.Stored + Infested.Stored.Season

C4.4.2: Accumulated analysis of deviance

Change	d.f.	deviance	mean deviance	deviance ratio	approx F pr.
+ **Infested**	**1**	**8.2192**	**8.2192**	**80.81**	**<.001**
+ Season	**1**	**0.4718**	**0.4718**	**4.64**	**0.042**
+ Infested.Season	**1**	**0.5211**	**0.5211**	**5.12**	**0.033**
+ Stored	1	0.0361	0.0361	0.35	0.557
+ Stored.Season	1	0.0164	0.0164	0.16	0.691
+ Infested.Stored	**1**	**0.5064**	**0.5064**	**4.98**	**0.035**
+ Infested.Stored.Season	**1**	**0.6521**	**0.6521**	**6.41**	**0.018**
Residual	24	2.4410	0.1017		
Total	31	12.8640	0.4150		

C4.4.3: Predictions from regression model – Infested soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Infested	Prediction	s.e.
Control	**8.625a**	**0.8484**
Infested	**3.063b**	**0.3012**

C4.4.4: Predictions from regression model - Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Season	Prediction	s.e.
Summer	**6.625a**	**0.7055**
Winter	**5.063b**	**0.5227**

C4.4.5: Predictions from regression model – Infested soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Infested				
Control	**9.500a**	**1.2130**	**7.750a**	**0.9896**
Infested	**3.750b**	**0.4788**	**2.375c**	**0.3031**

C4.4.6: Predictions from regression model - Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Prediction	s.e.
Stored		
Immediately	6.063a	0.6215
Stored	5.625a	0.5714

C4.4.7: Predictions from regression model - Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Season	Summer		Winter	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	6.750	0.9699	5.375	0.8062
Stored	6.500	0.9302	4.750	0.7018

C4.4.8: Predictions from regression model – Infested soils and Stored soils

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

Infested	Control		Infested	
	Prediction	s.e.	Prediction	s.e.
Stored				
Immediately	8.500a	1.0588	3.625b	0.4640
Stored	8.750a	1.0994	2.500c	0.3168

C4.4.9: Predictions from regression model – Infested soils, Stored soils and Season

The standard errors are appropriate for interpretation of the predictions as summaries of the data rather than as forecasts of new observations.

Response variate: Radicle length

	Infested	Control Prediction	s.e.	Infested Prediction	s.e.
Stored	Season				
Immediately	Summer	9.500a	1.5149	4.000b	0.6378
	Winter	7.500a	1.1959	3.250b	0.5182
Stored	Summer	9.500a	1.5149	3.500b	0.5581
	Winter	8.000a	1.2757	1.500c	0.2389