Germination potential of *Seriphium plumosum* (bankrupt bush, slangbos or vaalbos)

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Introduction

Seriphium plumosum, generally known as slangbos, bankrupt bush or vaalbos (formerly known as *Stoebe vulgaris*) is indigenous to South Africa and already widely distributed in various parts of our country (Eastern Cape, Free State, Mpumalanga, North West Province and Gauteng) (Schmidt *et al*. 2002, Badenhorst 2008). This aggressive encroacher endangers valuable grassland, which is and will remain the cheapest forage for the livestock farmer. This highly unpalatable fynbos shrub is very difficult to control as almost no animal utilizes this plant. It is not wholly true that encroachment is due to only mismanagement like overgrazing (Hatting 1953), as *S. plumosum* rapidly spreads on a farm after first occurring there (Richter 1989; Wepener 2007). The encroachment could also be as a result of a lack of controlled burning and selective grazing particularly by sheep since settled livestock farming development in these problem areas (Trollope 1987). The main reasons for the enormous explosion of it, especially over the past five to ten years, remain a mystery.

Very little has been published on the physiological, phenological and ecological aspects of this plant. 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 favour the establishment of this woody species (Wepener 2007). This plant first develops on the southern slopes then spreads to the valleys and seldom occurs in the vlei areas. It is also only limited to areas with an annual rainfall of 620 to 750 mm (Hatting 1953).

The shrub flowers mainly in the autumn/winter (April to June) and spring (Badenhorst 2008). Millions of very light seed are produced which can be widely distributed by wind (Hatting 1953, Richter 1989). Very little is known of the actual germination and the conditions contributing towards its most aggressive encroachment. This study aimed to determine the germination potential of *S. plumosum* at different sites where the grassland has already been encroached. This information is an important factor in determining control measures for this aggressive encroacher shrub.

Procedure

The research was conducted in the districts of Zastron, Thaba Nchu, Ladybrand and Clocolan with an annual rainfall that varies from 600 to 650 mm and altitude from 1 400 to 1 600 m. Temperatures vary from -11°C to 38°C, with an average of 17°C. The data were collected from a Moist Cool Highveld Grassland vegetation type described by Bredenkamp and Van Rooyen (1996) or *Cymbopogon – Themeda* veld type (A 48) as described by Acocks (1988).

The soil is a fine, sandy, loam soil which varies between Kroonstad, Estcourt and Westleigh forms (Soil Classification Working Group 1991). The percentages of clay in the A – horizon varies between 9 and 10% and pH (KCl) between 4.79 and 4.89.

In each of the four districts, a site was identified (0.5 ha) where *S. plumosum* encroachment occurred. These sites were situated against the slope of a ridge. The number of *S. plumosum* plants varied from 1 000 to 2 000 plants per hectare. In each site, the soil beneath 10 randomly selected shrubs was gathered to a depth of 50 mm. The shrubs were selected to be of more or less similar size from which 0.25 m^2 of soil was collected underneath each shrub. Some of the seeds can remain on the plants for several months before they are dropped and therefore the shrubs were hit with an object to get all possible seed on the soil before soil samples were taken. Although the selected plants flowered during spring (July/August) the seeds were not dropped at the time of soil sampling. Only the Thaba Nchu shrubs were hit. Soil samples for the seed bank test were taken at the end of August 2008.

The research was further continued in the greenhouse with respective day and night temperatures of 32°C (± 2°C) and 18°C (± 2°C). In the greenhouse, soil samples were evenly spread (50 mm deep) in plastic containers (0.5 m x 0.5 m) containing a 100 mm deep layer of Hygiotech growth medium (Canadian peat, polystyrene vermiculite and mono-ammonium phosphate). Separate containers were used for the soil of each shrub. Seedling plastic containers were randomly placed in the greenhouse and hand-watered daily.

The germination of *S. plumosum* was monitored over a period of two months by counting all the seedlings which germinated. To facilitate the counting of *S. plumosum*, the forbs and other grasses that emerged over this period were pulled out.

Results and discussion

A very fast germination is expected from such a small *S. plumosum* seed (Snyman 2004), which was not the case in this study. The first seeds in the seed bank germinated five weeks after watering. After six weeks no further germination took place up to week twelve. Surprising was that during weeks 14 and 16 another explosion of germination took place. In the past some researchers made wrong decisions from poor germination observations (Hatting 1953), without taking into account the initial delayed germination phase of this shrub. This delay can have positive or negative implications on the encroachment process of this shrub. The negative aspect is that it allows the seed to be distributed over very long distances by wind before optimal germination can take place. The positive is that grasses, the mush faster germinator after rain, can compete stronger for water and minerals and can therefore depress *S. plumosum* seedling establishment. In these areas a drought is more the rule than the exception and therefore it could also be possible that during limiting soil water conditions over these long germination periods, *S. plumosum* seedlings can die off.

Five weeks after watering a very high numbers of seedlings occurred in the seed bank for all districts (Table 1). Over this time only Clocolan produced statistically significantly ($P < 0.01$) fewer seedlings in the seed bank than was the case in the other districts. There are many possible reasons for this lower number of seedlings found at Clocolan, including that the shrubs may have been smaller or less seed could have been produced the preceding season than in other districts. The most logical cause can be ascribed to the soil and climate differences between the various districts. The germination of the Clocolan seeds took more or less one week longer than that of the other districts. The

Table 1: Number of *Seriphium plumosum* seeds germinating (seedlings per bush and per m^2) from the soil seed bank, at different times and for different districts. Means (n = 10) within a column with identical letters are not significantly different at $P < 0.01$.

	Seedlings			
	After 5 to 6 weeks		After 14 to 16 weeks	
Districts	Per shrub	Per m^2	Per shrub	Per m^2
Thaba Nchu	147^a	588^a	110^a	440^a
Zastron	141^a	564^a	81^a	324^a
Clocolan	98^b	392^b	39^b	156^b
Ladybrand	148^a	592^a	85^a	340^a

Clocolan shrubs perhaps flowered later and therefore the longer rest period needed for the seeds for optimal germination. Clearly, *S. plumosum* encroachment is similarly dangerous regardless of the environment.

The values in Table 1 must be viewed against the background of researchers' findings that if more than 10 000 *S. plumosum* plants occur per hectare, the production potential of the grassland can be decreased by up to 70 to 80% (Richter 1989, Jordaan and Jordaan 2007). Further, these seedling numbers (Table 1) are shocking as they are expressed per m^2 and not even per hectare. The positive is that, although each shrub produced millions of seeds each season, only these few germinate at the end. It is observed that the seeds can form a yellow layer underneath a shrub after seed dropping with the potential to germinate.

The fact that no seeds germinating between weeks 6 and 14 could be that fresh *S. plumosum* seeds need a post-resting period which had to be lifted before optimal germination can take place (Snyman 2004). In the case of the first germination after five weeks of watering, the post-resting period was perhaps lifted by the cold winter period. On the other hand, the fresh seeds without completing their rest period landed on the soil in August for the first time and germinated 14 weeks later and therefore the big gap between the two germinating periods. Interesting was that for the second germination, significantly more ($P < 0.01$) seeds germinating from the Thaba Nchu soil seed bank than from the other districts. The striking of these shrubs allowed dropping of all fresh seeds from the shrubs and therefore this higher germination after lifting the rest period. The reason only few seeds germinated from the Zastron, Clocolan and Ladybrand soil seed banks could be that only a few fresh seeds accidentally dropped from the shrubs at the time soil sampling took place. Although the number of developed seedlings is less during the second germination period, it is still a reason for concern for the encroachment of this shrub, because these seeds will reach optimal germination at a later stage. It is clear that over the season there will always be seeds only waiting for environmental conditions to be suitable for germination. These results clearly show our limiting knowledge on the dynamics of this problem plant.

If an average sized *S. plumosum* plant, which has already produced seed, removed from the grassland mechanically or by fire, would result in an explosion of seed germination due to lifting the overshadowing effect on surrounding plants (Snyman 2009). Therefore, care must be taken that follow-up action accompanies *S. plumosum* control measures. Without such an action, the whole encroachment problem would only worsen. The advantage of chemical control is that the active killing agent also results in a few years of residual effect, thereby inhibiting emerging seedlings.

It is astonishing that such a very small seed as that of *S. plumosum* can successfully germinate and establish in a dense cover of grassland in good condition. The fact that only a limited number of very young *S. plumosum* plants are normally found between grass tufts in grassland in good condition over a season is heartening as millions of viable seeds are produced by a shrub, which possibly do not immediately germinate due to competition. Allelochemic substances produced by the plant could be the reason why no young *S. plumosum* plants establish near mature shrubs (Squires and Trollope 1979). The possibility of an allopathic substance in *S. plumosum,* which contaminates the soil where it suppresses the germination of seeds is investigated at present (Snyman 2009). The longevity of these small seeds is an aspect requiring in-depth investigation and will contribute towards the application of successful control measures. Overgrazing, accompanied by a decrease in plant cover, create the ideal conditions for the viable *S. plumosum* seed to germinate in mass and rapidly encroach in the grassland. Old crop lands are especially prone to *S. plumosum* encroachment due to the lack of competition by grass species (Wepener 2007). As indicated in the literature (Smit 1955, Jordaan and Jordaan 2007, Badenhorst 2008), it is probably true that *S. plumosum* mostly flowers during autumn/winter and spring, but according to the latest observations seeds occur throughout the growing season on the shrubs, which further facilitates its distribution. Some seeds can remain on the plants for several months before they are dropped (Wepener 2007).

It was also observed that a *S. plumosum* seedling established this year will already flower in the same season.

Conclusion

Seriphium plumosum is presently viewed as one of the most significant problem plants in South Africa and without definite action with the control thereof, our precious grassland is facing a severe dilemma. Overgrazing probably leads to the appearance of the shrub, but actually only contributes towards its encroachment by decreasing the grass cover and allowing shrubs (which are not utilized) to grow and increase undisturbed. The enormous germination potential of the seed after controlling the shrub by cutting or burning has not always been realized in the past. These control measures must be managed correctly in terms of follow-up treatments which have to be applied. Therefore, underneath a shrub an infinite number of viable seed lie in waiting for favourable environmental conditions to explode in terms of germination. From this study it was clear that *S. plumosum* seeds are taking a very long time (5 weeks at least) to germinate and also need a post-resting period (more or less 3 to 4 months) to be lifted. These aspects must form part in the selection process for different controlling measures for this shrub.

The Conservation of Agricultural Resources Act legislation lists this plant as a proclaimed encroacher. Therefore the soil owner is responsible for its control where natural vegetation is being encroached. The control and eradication of *S. plumosum* is the subject of widely differing opinions. Therefore further in-depth research is required on this problem plant. Control measures do exist which can be successfully applied.

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