CHAPTER 1

INTRODUCTION

In 1859 Darwin wrote: "... if we wish in imagination to give the plant the power of increasing, we should have to give it some advantage over its competitors, or over the animals that prey on it."

Dry matter production in vegetation is subject to a wide variety of environmental constraints. These include shortages and excesses in the supply of solar energy, water and mineral nutrients. According to Grime (1977) plant species and even different genotypes may differ in susceptibility to particular forms of stress, and consequently each stress may exercise a different affect on vegetation composition. One of the most important forms of stress that plants which grow in close proximity face, whether they are of the same or of different species, is competition. Grime (1977) defines competition as the tendency of neighbouring plants to utilize the same light, mineral nutrients, water or space. The ability to compete for light, water, mineral nutrients and space are interdependent to the extent that natural selection has caused their development to a comparable extent in any particular genotype. Competition has therefore been associated with the evolution of a distinct strategy, and competitive ability is associated with characteristic and measurable genetic attributes which, by maximizing the capture of resources, facilitates the exclusive occupation of fertile, relatively undisturbed environments (Grime, 1977).

Three models of succession have been suggested by Connell & Slatyer (1977). In the first model of facilitation, the original species modifies the environment in such a way that it becomes more suitable for the following species in an ongoing process. The most important feature of facilitation succession is that the change in the abiotic environment is caused by the developing community. The entry and growth of the later species depends on earlier species preparing the ground. The tolerance model suggests that a predictable sequence arises because different species use different strategies to exploit resources. Species which develop at a later stage are able to tolerate lower resource levels and are able to grow to maturity in the presence of earlier species. These species are therefore stronger competitors than the earlier species. The inhibition model applies when all species resist the invasion of competitors. Later species gradually accumulate by replacing earlier individuals when they die. In the case of the facilitation and tolerance models, the early colonisers die due to competition. In the case of the inhibition model, however, the early colonisers die due to local disturbances caused by extreme physical conditions or due to the effect of consumers. Noble & Slatyer

(1981) attempted to formulate the role of different features, of different species, which determines their place in succession. The two most important features relate to the method of recovery and the ability of individuals to reproduce in the absence of competitors. According to Harper (1977) species react to selection pressure and develop features which enable them to survive for a longer period in the succession or they may develop more effective mechanisms of escape.

A theory on plant competition, aiming at analysing general principles by using models, suitable for quantitative treatment and formal interpretation of many competition phenomena, was introduced by De Wit & Ennik (1958), and detailed by De Wit & Van den Berg (1965) and Tow et al. (1966). The design of De Wit (1960) has proved popular due to the ability to identify and differentiate between superior and inferior competitors, and the extent of niche overlap between species, by mathematical means.

An understanding of the mechanisms that regulate population size in plant communities is of vital importance to both pure and applied ecologists. Throughout the history of ecology one school of thought (Antonovics & Levin, 1980) maintained that populations of plants are in some way regulated by density - dependent factors, i.e. processes that either increase mortality or decrease fecundity as the density of the population increases. According to Antonovics & Levin (1980) a density - dependent feedback exists that holds the population within certain limits.

A second school of thought (Antonovics & Levin, 1980) maintains that density - independent factors (e.g. weather conditions or disturbance) are more important in determining population size. Whether populations are regulated by density - dependent or density - independent factors has been a subject of intensive debate and controversy. Much of the controversy stems from a lack of adequate information about density - dependent regulation and its effects on a population; and more specifically the effects of density stress on the individual plant.

Populations of higher plants may vary in growth rate or mortality in reaction to stress. Mortality tends to be a continuing process throughout the life of dense populations and Yoda et al. (1963) showed that there was a relationship between the mean size of the surviving plants and the residual density at various stages in the development of a population. The distribution of matter within the plant and the form of the plant are products of complex developmental processes which depend on, among other things, the supply of assimilates, distribution of active growth hormones and environmental history. A technique, known as growth analysis (Kvet et al., 1971), has been developed in which ecological phenomena such as the success of species in various habitats, competition among species, genetic differences in yielding capacity and effects of agricultural treatments on crop growth can be investigated. According to Kvet et al. (1971), growth analysis is useful to analyse net photosynthetic production by plants, net production being defined as the net result of the assimilatory work taking place in a plant during a certain period of time.

The most common criteria for choosing purported competitors have been taxonomic relatedness or morphological similarity on the assumption that these factors imply an overlap in resource use. Brown et al. (1979), however, pointed out that the most important competitive interactions are not necessarily among similar pairs of species. All plants use essentially the same resources and thus all individuals in a community are potential competitors. It is therefore critical to have some objective means of determining the most important competitors for a given plant species, particularly if we wish to evaluate the effect of competition on the distribution and abundance of that species.

The aim of the study was therefore to identify the competitive ability of two important key grass species of South African pastures and to determine the effects of competition on their growth and overall production. Anthephora pubescens and E. curvula are both perennial tuft grasses which occur on sandy soils in Savanna, Grassland and Nama - Karoo biomes (Gibbs Russel et al., 1990). Anthephora pubescens has the ability to resist high temperatures and perform well in warm semi - arid areas with moderate to high maximum and minimum temperatures. A valuable attribute of this species is that it is a palatable climax grass with a high yield on nutrient - poor soil (Roberts & Fourie, 1975). Eragrostis curvula is a cultivated pasture with a wide distribution and is often used for the control of erosion (Gibbs Russel et al., 1990). Much work has been done on the utilisation of both pasture species as hay or grazing crop, but as differential components. Although these two species do not normally occur together in nature, it was aimed to evaluate their yielding potential if intercropped. The economic viability of pasture species in a third world continent is not only essential, but critical.

The thesis is presented in the form of papers. The papers have been submitted for publication in various scientific journals. A general introduction, a brief chapter on methods, a general conclusion and a comprehensive list of references are included in addition to the papers. The papers represented show some stylistic irregularities due to differences in layout and style required by various journals.