SOME ASPECTS OF THE COMPETITION BETWEEN SEEDLINGS OF GORSE (*ULEX EUROPAEUS* L.) AND "GRASSLANDS NUI" PERENNIAL RYEGRASS (*LOLIUM PERENNE* L.)

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Focas Kazingoma Mwatiká Mlowe

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ABSTRACT

Two glasshouse trials were conducted with "Grasslands Nui" perennial ryegrass (*Lolium perenne* L.) and gorse (*Ulex europaeus* L.) grown in boxes separately as monocultures and as mixtures forming a replacement series. The first trial was continued for 22 weeks after sowing to assess the effects of defoliation at 2 and 4 cm in comparison with controls. Defoliated treatments were cut 14, 18 and 22 weeks after sowing and the harvested dry matter weighed. In the second trial, the response of the two species to eight fertilizer treatments (nil, N, P, K, NP, NK, PK and NPK) was assessed 18 weeks after sowing.

In trial one, Nui grew faster than gorse and produced more dry matter over all harvest periods. The proportion of gorse in mixtures increased with repeated cutting, while the Nui decreased.

Over all harvest periods, gorse growth was depressed in mixtures with Nui and even with the smallest proportion of ryegrass (1 Nui to 3 gorse), total weights of gorse shoots were reduced by about 75%. The total root and whole plant dry weights followed a similar pattern as did the numbers of root nodules. The ratios of shoot:root weights were higher in mixtures than in monoculture.

With gorse, between the first and second cuts the low cut treatment outyielded the high cut but with subsequent cuts the low cut plants made less growth. Total shoot, root and whole plant weights and root nodule numbers were depressed by both defoliation treatments in comparison with the uncut controls and the depression was greater with the lower than the higher cutting level. The shoot:root ratio and side shoot numbers were higher in the defoliated than in the undefoliated treatments.

The total growth of Nui was not significantly reduced when grown in mixtures at ratios of 1 gorse to 3 Nui or equal numbers of each. At the 1 Nui to 3 gorse ratio, however, Nui growth was reduced by almost 20%. The shoot:root ratios and number of tillers per box were higher in monocultures than in mixtures.

Cutting reduced the final dry weights of Nui. The number of tillers was also decreased while the shoot:root ratio was increased. The effects of the second and third cuts were greater than those of the first cut but there was no significant difference between the two cutting heights.

Analysis based on de Wit's competition model showed that Nui was more competitive than gorse for most of the yield components measured and suggested that in most cases the two species were competing for different space. Gorse was at a competitive disadvantage when grown in association with Nui, both in the defoliated and undefoliated treatments. Increasing the proportion of ryegrass in mixtures severely restricted the growth of gorse seedlings. The high growth rate of Nui led to suppression of gorse by shading and the effect was accentuated by defoliation.

In the second trial, gorse produced a greater dry weight of shoots than roots while with Nui a greater weight of root was produced than shoot. As in the first trial, the grass made considerably more growth than the gorse. In the mixtures which contained 75% gorse and 25% Nui plants, the dry matter production of gorse shoots + roots was only 16% of the total of the two species. Nodule production per plant was reduced by about half.

Gorse dry weights,nodule numbers and shoot:root ratios were higher with all treatments containing P than in the controls or boxes treated with N, K or NK. Fertilizer treatments did not affect the proportion of gorse shoots in the mixtures but there was a reduction in the roots with P treatments.

With the grass also, all P-treated boxes yielded more shoot and root dry weights and tillers than the control or N and K treatments. The total plant dry weight was higher than the control with all fertilizers except K. In contrast with gorse addition of P fertilizers reduced the shoot:root ratio.

The use of fertilizers and defoliation in relation to the control of gorse seedlings in the field has been discussed.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

APPENDICES

1. INTRODUCTION

The word competition in relation to plant ecology was first defined by Clements in 1907 and quoted by Clements, Weaver and Hanson (1929). He wrote, "Competition is purely a physical process. With few exceptions, such as the crowding of tuberous plants when grown too closely, an actual struggle between competing plants never occurs. Competition arises from the reaction of one plant upon the physical factors about it and the effect of the modified factors upon its competitors. In the exact sense, two plants no matter how close do not compete with each other so long as the water content, the nutrient material, and the light are in excess of the needs of both. When the immediate supply of a single necessary factor falls below the combined demands of the plants, competition begins". One aspect not mentioned by Clements is the type of interaction involving substances released from one plant which have an influence upon another, particularly an inhibitory influence. This type of interaction is known as allelopathy (Tukey 1969; Whittaker and Feeny 1971; Whittaker 1975) and was observed as early as 1832 (Krebs 1973).

The use of the word competition to describe interactions between plants has been criticized by Harper (1961; 1964) because it lacks an independent scientific meaning and has a different significance in such fields as sports, games, economics and animal ecology. Instead he prefers to use the word interference to describe those effects which are caused by the proximity of neighbours. He defines plant interference as the response of an individual plant or species to its total environment as this is modified by the presence and/or growth of other individuals or species. He also distinguishes between competitive and non-competitive interference between pasture species. Competitive interference describes a situation where one species directly affects the growth of another by competing for a resource or resources potentially equally available to both. Non-competitive interference on the other hand occurs when one species is favoured by the presence of another. The latter can be illustrated by the example of a grass growing in the presence of a legume which fixes atmospheric nitrogen and makes it available to the grass. It could also apply to the protection of one species protected from grazing by thorny tree branches or a coarse unpalatable species. Donald (1963), however, argues that, "despite the confusion that has at times occurred in the use of the word competition, it seems that if it is used in its original meaning, and according to the biological concepts of Clements, it is well suited to a clearly delineated set of biological situations. There is no reason to discontinue the use of this simple and effective term."

An important feature of most natural ecosystems is that the overall habitat varies so that no single species ever dominates large areas to the exclusion of all others. Monospecific stands are thus less common than multispecific and pure cultures are rarely found, except in such extreme environments as swamps or saline areas of limited extent. Even in a monoculture, intraspecific competition takes place when one individual grows sufficiently close to another to modify the avilable supplies of water, nutrients, light, etc. and thus decreases its rate of growth (Milthorpe 1961; Donald 1963).

In natural plant communities, the climax vegetation represents the position of relatively greates equilibrium between the vegetation and its environment (Tansley 1953). Tropical grasslands, however, are not natural climax communities but have mostly been induced by pastoral farming or fire or are maintained by the constant cutting of brush for fuel (Whyte 1962). Over the greater part of Central and East Africa, for example, the climax vegetation appears to be some type of forest, woodland or bush (Little and Ivens 1965; Pratt *et al.* 1966). Grasses may occur in these vegetation types but they are normally the dominant species. Many ecologists cited by West (1965) consider tropical grasslands to be artificial because they grade into a forest on their more humid boundary and into bush on their arid boundary. Because of the fact that the present appearance and composition of vegetation give a poor indication of the true potential of a site, for East African rangelands, Pratt *et al.* (1966) have classified them by employing two complementary systems. The first is defined primarily by climate but incorporates vegetation and land-use descriptions and the second comprises vegetation types which are recognized by their forms and relative contributions of woody plants and grass.

True grasslands are rare in the tropics but may result from too much or too little moisture or from low temperatures. Thus the existance of open 'mbuga' grasslands in East Africa is due to water-logging during the rainy season, steppe grasslands are due to limited precipitation and alpine grasslands result from the low temperatures occurring at high altitude. Such grasslands do constitute climax vegetation types and can be relatively easily maintained by good grazing management.

Rangelands carry natural or semi-natural vegetation which provide feed for domestic and wild animals (Semple 1970). They are unsuitable for development of aritificial pastures because of the scanty and erratic rainfall. Man-made pastures are normally developed from forest or woodland under mesic conditions. The basic problems are those of removing the existing native vegetation and controlling the regrowth. In New Zealand, for example, much of the 8.5 million ha of sown pasture (Leonard 1973) has been developed from subtropical rainforest. Problems inevitably arise from native species establishing as the first stages of reversion to forest but more serious problems occur as a result of the introduction of species from abroad. Of the native woody species which tend to reinvade grassland, the most important is manuka (*Leptospermum scorparium* J.R. & G. Forst), which is the main nurse plant of the indigenous forest. This plant has remarkable powers of regeneration from seed and can readily reinvade pastures. Of the introduced brush species, gorse is the most important. It occupies about 40,000 ha of potentially highly productive land (Currie 1959) and has taken over more than 500,000 ha of low producing, mostly unploughable hill country where it is much harder to eradicate (Mason, 1973). The dormancy and longevity of the seed in the soil and the plant's capacity to regenerate after burning or cutting are the main factors involved in the persistence of the gorse problem.

During pasture establishment on land cleared from gorse, many seeds germinate which can rapidly re-establish the infestation. Gorse seeds are hard and remain in the soil for many years. In areas being cleared from gorse, Moss (1959) recorded 35,000,000 viable seeds of gorse per ha. The importance of these buried seeds is emphasized by Anon (1973) who points out that only 12,000 germinating seeds can completely smother one ha of good land in three years.

The reversion and invasion of brush species into New Zealand pastures (Levy 1970) has been the result of poor pasture vigour due to poor management leading to the depletion of organic matter and mineral nutrients. There has also been a loss of top-soil on much steep country. Seedling invasion is less of a problem if the pasture can be ketp thick and stock numbers are sufficient to kill the bush seedlings or keep them under control. In practice, on much hill country it is difficult to maintain sufficient grazing pressure owing to fluctuations in weather and soil type, and to such factors as pugging, slips and the high cost of fencing (Currie 1959). Nevertheless, mob-stocking with at least 200-750 sheep per ha (see section 2.3.5.4) for short periods is an effective method of limiting the invasion of woody weed seedlings and is strongly recommended as a management practice in gorse control schemes.

Rolston and Sineiro-Garcia (1974) in defoliation work on gorse, subjected seedlings to various intensities of cutting. The results showed that only seedlings defoliated well below the cotyledons were killed. From field observations they concluded that a grazing intensity sufficient to defoliate seedlings below the cotyledons is difficult to achieve in practice. However, it is probable that other factors associated with grazing may be important in controlling seedlings especially treading and pulling effects.

The use of fertilizers is also important in the establishment of pasture after clearing gorse or other woody weeds. High levels of nutrients are needed to obtain the most vigorous growth of pasture species and vigorous pasture growth offers the greatest degree of competition to bush seedlings. Practical gorse control recommendations stress the importance of heavy top-dressing in combination with oversowing (Matthews 1975, 1976; Anon 1974a).

The pasture species sown must also be highly competitive. Although it may be too early to recommend "Grasslands Nui" perennial ryegrass, generally studies have shown the superiority of this variety over ARiki and Ruanui in total dry matter production, seasonal production, persistence and compatibility with clover (Armstrong 1978). The superior qualities include a rapid growth rate, ability to produce more with age and the ability to withstand the hard grazing pressure which is necessary under mob-stocking.

A better knowledge of the processes involved in pasture establishment throw more light on the factors that can be controlled and the methods available for the improvement of production. These include seedbed preparation, time of sowing, seed quality, fertilizer application, good grazing and pasture management. Together they should be directed towards maintaining as vigorous a cover as possible in order to smother established weeds and inhibit the establishment of seedlings. Control of gorse through pasture competition is more important than chemicals because seedlings come up after the chemical has gone and because chemical control is expensive and alters the pasture composition.

Pasture species have been the subject of a considerable amount of work on competition, particularly the associations of grasses and legumes (Herriott 1958; Donald 1963; Harris, 1968). Little information is available, however, on the competition between pasture species and weeds and woody weeds have been especially neglected. The present investigation has been conducted to study the nature of the interactions between seedlings of gorse and "Grasslands Nui" perennial ryegrass when subjected to a range of defoliation and fertilizer treatments under glasshouse conditions. It is hoped that a better understanding of the competition between these two species will show up weaknesses of the weed that can be exploited in the development of improved methods of control.