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Allelopathic effect of the weed *Cyperus esculentus* on the growth of young *Pinus patula* plantations

by

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Certification

This is to certify that, except where otherwise stated, the work reported in this thesis is that of the author, and that it has not been submitted for this degree at any other university or institution of higher education.

S.R. Bezuidenhout

June 2001

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Dedication

To my parents, without whose continued support and interest I would not have had the determination to continue.

To my grandmother, whose love for knowledge inspired me to search for unanswered questions.

"It is more important to know where you are going than to get there quickly. Do not mistake activity for achievement. "

Abel Newcomer

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Almighty God,allowing me the privilege and opportunity of following my dream.

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Promotor : Prof. C.F. Reinhardt

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Abstract

Greenhouse trials were conducted at the University of Pretoria to ascertain whether interference from yellow nutsedge affected the growth and development of patula pine. The first trial was designed to investigate whether incorporated residues or root leachate of the weed was inhibitory towards growth. It was found that the incorporated residues inhibit not only growth but also the growth of mycorrhizae associated with patula pine. In the second trial aqueous extracts of the different growth stages of yellow nutsedge were prepared, and tested against the growth of lettuce and the mycorrhizae associated with the pine seedlings. It was concluded that at both the immature and mature growth stage of the weed, the most inhibition towards lettuce and mycorrhizal growth occurred. The third trial involved growth of the pine species together with yellow nutsedge. In the absence of the weed, pine growth was not affected compared to seedlings growing with the weed. Results from the pot trials were confirmed in a field trial. Seedlings growing in the presence of yellow nutsedge showed a significant growth reduction compared to those growing without weeds. This study showed that yellow nutsedge contains compounds, in especially the immature growth stage, that are inhibitory towards the growth of patula pine.

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Introduction

The production of timber plays an important role in the economy of South Africa, and the demand for wood for paper, mining and building is increasing with an increasing population. Agriculture and forest development are subjected to changes in technology, market forces and political pressures. Major limitations to development are the physical constraints of climate. Therefore, the identification of areas suitable for afforestation is a challenging and formidable task.

The foregoing explains why the forestry industry is progressively acquiring land that was previously used for agricultural purposes (Noble & Schumann, 1993). These land areas are typically a mixture of natural vegetation (afforested soil) and old agronomic sites (oldland soil). Oldland soils may differ from afforested soils with respect to pathogens, weed spectrum and soil nutrition (Smith & Van Huyssteen, 1992). The weed community on oldlands consists virtually exclusively of annuals that commonly occur in annual crops, e.g., *Cyperus esculentus* (yellow nutsedge), *Bidens pilosa* (common blackjack) and *Conyza albida* (tall fleabane). On adjacent afforested soil, natural grass species dominate (Reinhardt, Khalil, Labuschagne, Claasens, & Bezuidenhout, 1996).

In Mondi Forest's nurseries, pine seedlings are grown in containers for six months before they are transplanted in the field. *Pinus patula* (patula pine) established on soil under natural vegetation typically do not experience any growth and developmental problems. However, when seedlings are established on old agronomic sites, growth and development abnormalities are encountered. According to Linde, Kemp & Wingfield (1994), mortality of the seedlings was greater than 95% in most

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cases in the north-eastern Cape Province of South Africa. The pine seedlings on oldlands died approximately 4-5 months after they were established in the field. It was reported by Smith & Van Hyussteen (1992) and Schumann & Noble (1993) that the symptoms of poor seedling performance involved a minimally developed root system, stunting, lack of apical dominance, chlorosis and necrosis of fascicles and necrosis of the growth tips.

The disorder is referred to as the "oldland syndrome". Various attempts to solve or amend the problem were launched and included soil, pathogen and mycorrhizal studies (Marais, 1974; Noble & Schumann, 1993; Schumann & Noble, 1993; Linde *et al.*, 1994 and Viljoen, Wingfield & Marasas, 1994). However, the problem appears to be complex and probably can not be attributed to one factor alone.

The role of allelopathic weeds, in particular their effects on forestry and agroforestry, had not been investigated in terms of the oldland syndrome in forestry situations in South Africa prior to 1995. The impact allelopathic weeds can have on the growth of forestry species are known. Rietveld (1975) demonstrated the adverse allelopathic effect of grass residues on the germination and early growth of *P. ponderosa* (ponderosa pine). Gilmore (1985) noticed the erratic establishment of *P. taeda* (loblolly pine) on old fields covered with *Setaria faberii* (giant foxtail). Jobidon, Thibault, & Fortin (1989) investigated the potential harmful effects of straw of *Avena sativa, Hordeum vulgare* and *Triticum aestivum* on *Picea mariana* (black spruce) seedlings. Height growth was not affected, but manganese uptake was inhibited.

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One weed species in particular, *Cyperus esculentus* (yellow nutsedge), was the common denominator in terms of the weed spectrum found on the oldlands in the forest plantations. The allelopathic potential of this weed on higher plant species, has been investigated by several researchers (Horowitz & Friedman, 1971; Tames, Getso & Vieitez, 1973; Meissner, Nel & Smit, 1979 & Drost & Doll, 1980).

Consequently, the main objective was to quantify the allelopathic effects of *Cyperus esculentus* on the growth and development of *P. patula* seedlings under controlled and field conditions.

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Literature Overview

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