GROWTH, ANATOMY, QUALITY AND YIELD OF WILD GINGER (*SIPHONOCHILUS AETHIOPICUS*) IN RESPONSE TO NITROGEN NUTRITION, FERTIGATION FREQUENCY AND GROWING MEDIUM

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DECLARATION

I hereby declare that the work herein submitted as a dissertation for the Masters of Science in Agriculture (Agronomy) degree is the results of my own investigation. Work by other authors that served as sources of information have duly been acknowledged by references to the authors.

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DEDICATION

To our Father who art in heaven and His only Son who saves our lives, You are my reason for living, thank You for immeasurable knowledge, understanding and wisdom that You gave me.

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by

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Abstract

Wild ginger is an herbaceous perennial medicinal plant used for coughs, colds and flu as well as to treat malaria and also used for some other traditional and cultural practices. Due to its medicinal, wild ginger has become extinct from the wild due to over-harvesting. To improve its conservation, studies on wild ginger growth, rhizome ad enlarged root yield, anatomy and oil yield were conducted in either an open field, tunnel or a laboratory.

The response of wild ginger growth and yield to N nutrition was conducted in the field. Treatments used were six levels of nitrogen (0, 50, 100, 150, 200 and 250). All N treatments were applied at planting in the form of limestone ammonium nitrate Measurements were made of plant emergence, plant height, fresh rhizome and enlarged root mass, fresh rhizome circumference, length of enlarged root and the number of rhizomes and enlarged roots. There was a positive linear relationship in all yield parameters to nitrogen applied except for the number of rhizomes which had showed no relationship. This study revealed that N nutrition increased growth and yield of wild ginger.

The response of wild ginger growth, rhizomes and enlarged root yield as well as oil yield to fertigation frequency and growing medium were investigated in a tunnel. Treatments used were five fertigation frequencies (0.25L/day, 1L/day, 2L/day, 2L/2nd day and 2L/week) and two growing media (pine bark and sand). Measurements were made of plant height, number of leaves and stems at 56, 112, 168 and 224 days after emergence (DAE) and fresh and dry leaf mass and leaf area at 112 and 224 DAE.Yield was determined at 112 and 224 DAE. Fresh rhizomes and enlarged roots were hydrostilled for essential oil at 224 DAE. During the initial sampling date (56 DAE), all fertigation frequencies improved wild ginger growth except a

fertigation frequency of 2L/day. However, during later sampling dates (112, 168 and 224 DAE), all fertigation frequencies were ideal except 2L/week which was inadequate to sustain wild ginger growth and development. Plants grown in pine bark had increased growth at initial growth stages (56 and 112 DAE), but at later growth stages (168 and 224 DAE), plants grown in sand had increased growth. Fertigation frequency and growing medium did not affect fresh rhizome and enlarged root oil yield.

An experiment was conducted in a laboratory to determine the effect of nitrogen nutrition as well as fertigation frequency and growing medium on the enlarged root anatomy of wild ginger. For the nitrogen study, wild ginger plants were grown in pine bark under a glasshouse with either 0, 50, 100, 150, 200 or 250 $kg \cdot ha^{-1}$ N. Enlarged roots from the N study as well as the enlarged roots from the fertigation frequency and growing medium study (previously described) were harvested at 224 DAE for sectioning.

Anatomical structures observed were glandular cells, number of primary xylems and cells between them, size of pith, cortex, endodermis, pericycle layer and presence of starch grains. Glandular cells increased from two where no nitrogen was applied to eight where 250 $kg \cdot ha^{-1}$ N was applied. This study demonstrated N nutrition for wild ginger is important for increasing glandular cells that are important for essential oil production. For plants grown in pine bark, glandular cells increased from one where where plants received 0.25Lday to three where plants received 1L/day. For plants grown in sand, there were no glandular where plants received the highest fertigation frequency (2L/day) and increased to sixteen where plants received the lowest fertigation frequency (2L/week). More glandular cells were, therefore, produced in plants grown in sand with the least fertigation frequency (2L/week).

Keywords: N nutrition, fertigation frequency, growing medium, growth, yield, anatomy, oil yield

GENERAL INTRODUCTION

Wild ginger (*Siphonochilus aethiopicus*) is a rhizomatous perennial plant and belongs to the Zingiberaceae family (Holzapfel, Marais, Wessels & van Wyk, 2002). It has been an important tropical horticultural plant valued all over Africa for its medicinal properties and in South Africa is known as the Natal ginger, *sherungulu* and *indungulu* (Van Wyk, van Oudshoorn & Gericke, 2000). Smith, Crouch & Condy (1997) reported it to occur in Limpompo Province, Mpumalanga Province, Swaziland and KwaZulu-Natal Province and it is the only member under Zingiberaceae family indigenous to South Africa. However, there is controversy about its occurrence in these regions. More experienced researchers emphasized that the species seemed to have never occurred naturally in the flora area, but it was introduced from tropical Africa and widely cultivated (Holzapfel *et al.*, 2002; Lock, 1985; Smith *et al.*, 1997). Earlier authors recorded its presence as *S. natalensis* at Ngoye and Inanda and there have been tentative suggestions of its possible occurrence in some of the river valleys south of Durban and into Transkei (Van Wyk, Makhuvha, van der Bank & van der Bank, 1997).

The plant is generally propagated from matured rhizomes. Rhizomes were reported to be used for coughs, colds and flu and also used to treat malaria, hysteria and for chest complaints (Smith *et al.*, 1997; Van Wyk *et al.*, 1997). The highly aromatic enlarged roots are used as a protection against lightning and snakes (Van Wyk *et al.*, 1997). In addition, the rhizomes are also used in the treatment of horse-sickness.

Cunningham (1988) reported that pressure on wild ginger populations has led to local extinction, notably in KwaZulu-Natal, due to the fact that wild ginger cures many illnesses. Hence, more people are resorting to using it and as such face the danger of being extinct (Van Wyk *et al.*, 1997). It was stressed that there is a problem of having limited supply of high quality rhizomes and that this is compounded by over-exploitation in some regions of South Africa, KwaZulu-Natal in particular (Van Wyk *et al.*, 1997).

Demand for sustained, high crop-yield has led to the application of increasingly larger amount of commercial fertilizers to agricultural soils. This is particularly the case for nitrogen, since it is still relatively inexpensive compared to the worth of increased crop production (Bergstrom & Brink, 1986). Wild ginger is an important crop as far as human health is concerned. Therefore,

as a result of its many medicinal purposes it was vital that research be conducted to increase its production. Therefore, protecting the crop from being over-exploited in the wild is of utmost importance.

The objectives of the study were to: (a) determine optimal nitrogen rates and their effects on the growth, enlarged root anatomy and yield of wild ginger, (b) determine the ideal fertigation frequency and growing medium on the growth, quantity and quality of rhizome and enlarged root oil, enlarged root anatomy and yield of wild ginger.