Allelopathic potential of silverleaf nightshade

(*Solanum elaeagnifolium* Cav.)

by

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LIST OF ABBREVIATIONS

m	:	meter
cm	:	centimeter
mm	:	millimeter
cm^3	:	cubic centimeter
µm	:	micrometer
µl	:	microlitre
PEG	:	polyethylene glycol
mOsm kg^{-1}	:	milliOsmol $kilogram^{-1}$
LSD	:	least significant difference
UV	:	Ultraviolet
TLC	:	Thin layer chromatography
^{1}H-NMR	:	^{1}H nuclear magnetic resonance

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ALLELOPATHIC POTENTIAL OF SILVERLEAF NIGHTSHADE (*SOLANUM ELAEAGNIFOLIUM* CAV.)

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ABSTRACT

Silverleaf nightshade is a serious problem weed in many semi-arid regions of the world. Although many research efforts have been devoted to this weed's interference with crop species, possible chemical interference (allelopathy) has not been thoroughly investigated yet. In the present study, allelopathic potential of silverleaf nightshade foliage was assessed by means of germination bioassays. Preliminary experimentation was necessary to evaluate procedures of the bioassay method to be used, as many different approaches are described in literature. Water infusions and crude water-soluble extracts of silverleaf nightshade foliage inhibited germination and root growth of cotton and lettuce respectively. Osmolalities of the infusions or extracts used were not inhibitory to germination or root growth of either cotton or lettuce. Preliminary exploration of the nature of the chemical substances implicated in this phytotoxic activity suggests that more than one compound is involved. This includes an alkaloid, a saponin and several flavonoidic constituents, implying the presence of a synergistic effect for crude extracts. An anatomical study was conducted in an attempt to link the allelopathic potential of silverleaf nightshade foliage to specific cells or structures in the leaves. It was considered that glandular trichomes, abundant on both leaf surfaces, might harbour phytotoxic secondary metabolites. It was furthermore speculated that stellate trichomes with intrusive basal cells observed to reach

the vascular bundles, might be involved in excreting alkaloids contained in the vascular bundle sheath onto the leaf surface. The results of this study represent the first step in showing the allelopathic potential of silverleaf nightshade and laid a foundation for continuing with field studies and more in-depth chemical analyses.

ALLELOPATIESE POTENSIAAL VAN SATANSBOS (*SOLANUM ELAEAGNIFOLIUM* CAV.)

deur

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UITTREKSEL

Satansbos is 'n probleem onkruid in baie semi-ariede dele wêreldwyd. Alhoewel heelwat navorsing oor hierdie onkruid se inmenging met gewasplante reeds uitgevoer is, konsentreer dit hoofsaaklik op kompetisie en is daar min bekend oor satansbos se potensiële chemiese inmenging (allelopatie) met gewasse. In hierdie studie is die allelopatiese potensiaal van satansbos loof geëvalueer deur middel van ontkiemingsbiotoetse. Voorlopige eksperimentering was nodig om die korrekte kombinasie van prosedures vir die ontkiemingsbiotoets te vind, aangesien daar uiteenlopende benaderings in die literatuur voorkom. Wateraftreksels en kru wateroplosbare ekstrakte van satansbos loof het ontkieming en vroeë wortelgroei van katoen en slaai, onderskeidelik, betekenisvol geïnhibeer. Die aftreksels en ekstrakte wat in die biotoetse gebruik is se osmolaliteite was nie inhiberend ten opsigte van ontkieming of wortelgroei van katoen of slaai nie. Voorlopige ondersoeke na die chemiese aard van die fitotoksiese verbindings, het aangedui dat meer as een chemiese verbinding betrokke is. Dit dui moontlik op die teenwoordigheid van 'n sinergistiese effek in die kru ekstrak. Die verbindings is voorlopig geïdentifiseer as 'n alkaloïed, 'n saponien en verskeie flavonoïed-bevattende fraksies. 'n Anatomiese ondersoek is onderneem om 'n moonlike verwantskap tussen spesifieke strukture of selle in satansbosblare, en die allelopatiese potensiaal van die loof te vind. Die kliertrigome, gevind op beide die adaksiale

en abaksiale blaaroppervlak, mag moontlik fitotoksiese sekondêre verbindings bevat. Verder is daar gespekuleer dat die stervormige trigome, met basale selle wat die blaarmesofiel binnedring en die vaatbondels bereik, moontlik betrokke mag wees by ekskresie van alkaloïede wat in die vaatbondelskede voorkom. Die resultate van hierdie studie is die eerste stap om die allelopatiese potensiaal van satansbos aan te toon, en lê sodoende 'n grondslag vir toekomstige veldstudies en meer in-diepte chemiese navorsing.

INTRODUCTION

Solanum elaeagnifolium, commonly known as satansbos or silverleaf nightshade, is currently a serious problem weed in many semi-arid regions of the world, including South Africa (Boyd & Murray, 1982; Boyd *et al.*, 1984; Wasserman *et al.*, 1988). It is regarded as one of the most troublesome perennial weeds in cotton (Green *et al.*, 1987; Cilliers, 1999). But how exactly does this weed interfere with crop species? Several studies have already been carried out on the competition aspect (Green *et al.*, 1988) and interference as a whole (Green *et al.*, 1987; Smith *et al.*, 1990), but little attention has been paid to the chemical aspect of interference, termed allelopathy.

Phytochemical studies on silverleaf nightshade foliage and fruit have revealed the presence of alkaloids (Guerreiro *et al.*, 1971), sapogenins and flavonoids (Chiale *et al.*, 1991), which are well known chemical groups implicated in allelopathic effects (Rice, 1984; Putnam, 1985). There have been reports of phytotoxic activity of unidentified saponins from silverleaf nightshade fruit (Curvetto *et al.*, 1976; Agüero & Boland, 1985), however no literature could be located on the phytotoxic or allelopathic potential of silverleaf nightshade foliage.

Silverleaf nightshade has already been described botanically by several authors (Wasserman *et al.*, 1988), and limited anatomical work on the leaves has been reported (Cosa *et al.*, 1998; Dottori *et al.*, 1998; Bruno *et al.*, 1999). An anatomical description of silverleaf nightshade leaves might assist in understanding the potential allelopathic interference originating from the foliage of this weed with crop species.

Wasserman *et al.* (1988) identified inadequate knowledge of the weed silverleaf nightshade itself as one of the reasons why eradication campaigns against this weed failed. Priorities in actions against the silverleaf nightshade problem, according to these authors, should therefore include in-depth ecological and physiological studies of the plant and its seed.

This study was therefore aimed at contributing to existing knowledge of silverleaf nightshade by determining the existence of any possible allelopathic influence that silverleaf nightshade foliage might exert on crop species. Specific objectives were: (a) to evaluate the phytotoxic activity of water infusions and water-soluble extracts of silverleaf nightshade foliage towards crop species, (b) to obtain some preliminary information on the chemical nature of the fraction(s) or compound(s) responsible for phytotoxic activity, and (c) to examine silverleaf nightshade foliage by light transmitting and scanning electron microscopy (LTM and SEM), in order to describe the leaf anatomically and identify possible cells or structures that might harbour allelopathic compounds.