

Effect of soil Sulphur and Nitrogen on Isothiocyanate production within *Brassica* species and subsequent mycelial inhibition of *Rhizoctonia solani*.

SARDI



SOUTH AUSTRALIAN
RESEARCH AND
DEVELOPMENT
INSTITUTE

R. B. Harding

South Australian Research and Development Institute GPO Box 397, Adelaide, SA 5001

INTRODUCTION:

Members of the *Brassicaceae* family contain the compounds glucosinolates (GLS). As these compounds break down they release Sulphur containing volatiles known as isothiocyanates (ITC's), of which several have known biocidal effects (1,3).

The purpose of this study was to determine if soil treatments of Sulphur (S) and Nitrogen (N) induced higher production of GLS that are ITC liberating within different *Brassica* species and if ITC's released from root tissue inhibits the growth of the soil borne fungi *Rhizoctonia solani*.

METHODS:

Soil nutrient analysis was conducted across 5 replicate blocks within a field trial and appropriate elemental rates of fertilizer applied to achieve equal state of nutrition. Treatments were applied to whole plots as follows.

1. S (6ppm) at sowing
2. S (6ppm) at sowing + N (30ppm) 4 weeks post sowing
3. S (15ppm) at sowing
4. S (30ppm) at sowing
5. S (15ppm) + N (30ppm) at sowing

Sub plots were planted to individual species of *Brassica napus* (2809), *B. napus* (4063), *B. campestris*, *B. juncea* and *Raphanus sativus*. Leaf (L), root (R) and stem (S) tissue from 5 plants/subplot were collected at 10% flowering, freeze dried and ground subsamples analysed for ITC's. Amendments of root tissue were placed in inverted petri dishes containing a 5mm disc of *R. solani*. Water was added on a v/w basis to tissue and radial growth of fungi recorded 11 days after exposure.

RESULTS:

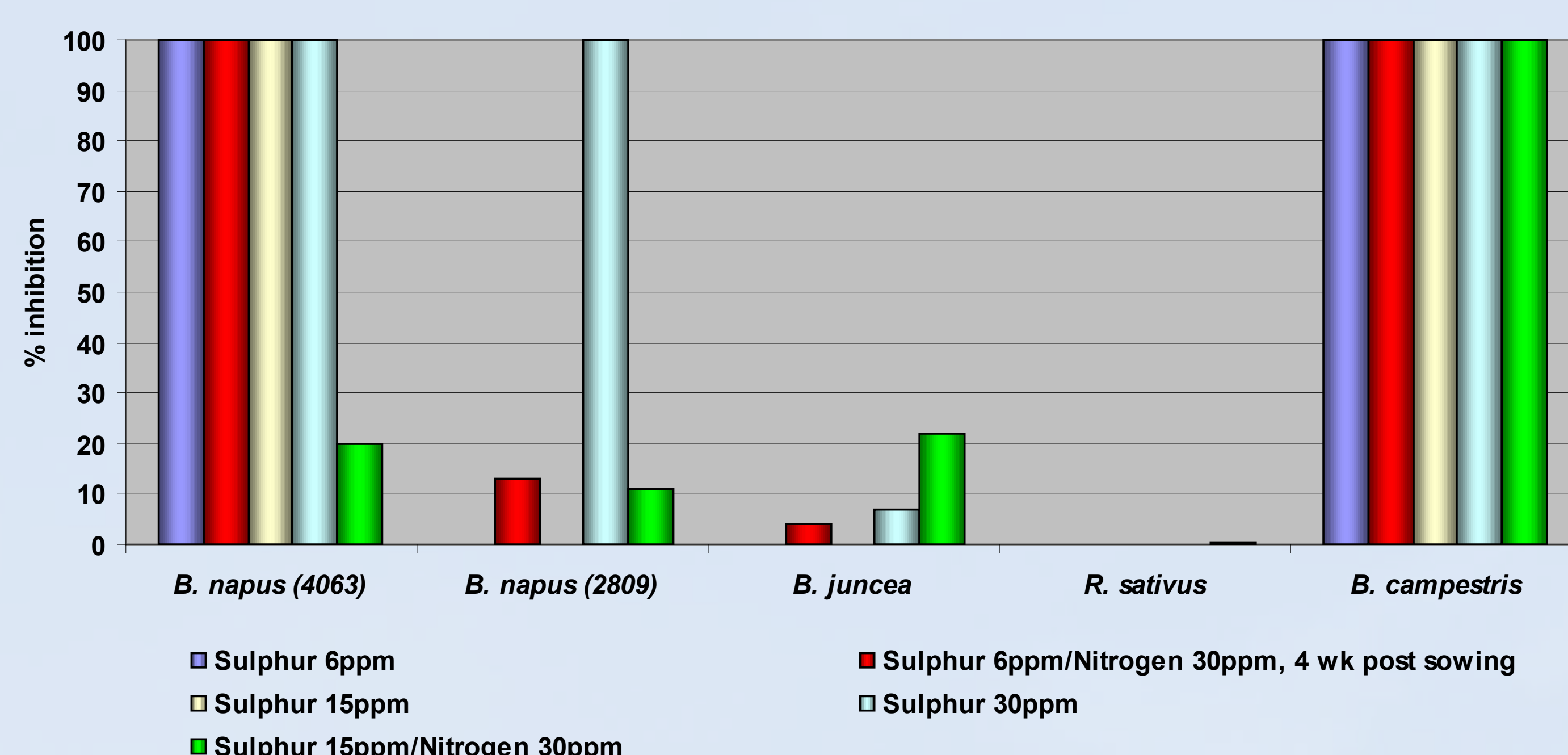
Levels of soil S and N varied significantly in their effect on individual and mean GLS concentrations between *Brassica* sp. (Table 1) and individual plant parts within sp. (data not shown).

Table 1. Mean individual glucosinolate concentrations of combined leaf, root and stem tissue collected from different *Brassica* sp grown in soil amended with different levels of Sulphur and Nitrogen.

Brassica sp	Soil treatment	Individual glucosinolate concentrations (umole/g ⁻¹)				
		2-Propenyl	3-Butenyl	4-Pentenyl	4-Methylthiobutyl	2-Phenylethyl
<i>B. napus</i> (4063)	Sulphur 6ppm	0	40.9	33.9	1.6 b	6.13 bc
	Sulphur 6ppm/Nitrogen 30ppm, 4 wk post sowing	0	37.5	28.7	1.1 b	5.31 c
	Sulphur 15ppm	0	37.7	33.4	1.6 b	7.88 ab
	Sulphur 30ppm	0	42.9	33.4	3.4 a	7.14 b
	Sulphur 15ppm/Nitrogen 30ppm	0	41.1	31.3	1.7 b	8.63 a
	LSD	n.s	n.s	n.s	1.01	1.28
<i>B. napus</i> (2809)	Sulphur 6ppm	0.00 b	18.7 bc	0.11	2.3	6.7
	Sulphur 6ppm/Nitrogen 30ppm, 4 wk post sowing	0.39 ab	23.3 a	0.14	2.0	6.5
	Sulphur 15ppm	0.51 a	22.5 ab	0.00	2.2	6.6
	Sulphur 30ppm	0.31 ab	20.9 ab	0.09	2.5	6.2
	Sulphur 15ppm/Nitrogen 30ppm	0.38 ab	16.3 c	0.00	2.5	6.5
	LSD	0.33	4.40	n.s	n.s	n.s
<i>B. juncea</i>	Sulphur 6ppm	17.1 c	38.8 a	0.84 a	0	5.6
	Sulphur 6ppm/Nitrogen 30ppm, 4 wk post sowing	17.8 abc	30.1 b	0.49 bc	0	5.6
	Sulphur 15ppm	21.0 ab	39.8 a	0.34 c	0	6.2
	Sulphur 30ppm	22.6 a	40.2 a	0.91 a	0	5.8
	Sulphur 15ppm/Nitrogen 30ppm	23.1 a	38.7 a	0.67 a	0	6.7
	LSD	3.77	5.25	0.25	n.s	n.s
<i>R. sativus</i>	Sulphur 6ppm	0	0.00 b	0	43.0 a	0
	Sulphur 6ppm/Nitrogen 30ppm, 4 wk post sowing	0	0.19 a	0	27.6 c	0
	Sulphur 15ppm	0	0.00 b	0	38.1 ab	0
	Sulphur 30ppm	0	0.00 b	0	31.1 abc	0
	Sulphur 15ppm/Nitrogen 30ppm	0	0.00 b	0	30.1 c	0
	LSD	n.s	0.08	n.s	7.08	n.s
<i>B. campestris</i>	Sulphur 6ppm	0	4.0 b	21.3	0.00 b	9.5 ab
	Sulphur 6ppm/Nitrogen 30ppm, 4 wk post sowing	0	6.1 b	24.3	0.08 b	6.5 c
	Sulphur 15ppm	0	14.7 a	27.0	0.30 a	8.2 bc
	Sulphur 30ppm	0	5.3 b	25.3	0.09 b	8.6 abc
	Sulphur 15ppm/Nitrogen 30ppm	0	3.5 b	23.2	0.08 b	11.1 a
	LSD	n.s	5.88	n.s	0.19	1.24

Freeze dried root tissue from all *Brassica* sp. except *R. sativus* reduced mycelial growth, however *B. campestris* was the only species that completely inhibited mycelial growth of *R. solani* (100%) from all 5 treatments (Figure 1).

Figure 1. Inhibition of mycelial growth of *R. solani* in the presence of rehydrated root tissue from different *Brassica* sp. grown in soil amended with different levels of Sulphur and Nitrogen.



DISCUSSION:

- This study shows significant variation exists in the GLS concentrations both within and between *Brassica* species, and that levels of S and N applied and timing of application are dependant on the species grown for the GLS levels required.
- Results confirm the antifungal effects of *Brassica* residues to soil borne pathogens and the strong correlation with the presence of GLS degradation products.
- The GLS profiles of all species was dominated by aliphatic GLS's except in *B. campestris* where aromatic GLS's were more dominant. This may explain why *B. campestris* was more inhibitory to the mycelial growth of *R. solani* than any other species, as ITC's derived from aromatic GLS's (eg 2-phenylethyl) have been found to be 20 – 40 times more toxic than the aliphatic compound 2 – propenyl ITC (2). However *B. napus* (2809) contained similar concentrations of 2-phenylethyl as *B. napus* (4063) but did not inhibit mycelial growth to the same extent. In this case other chemicals, independent of the glucosinolate allelopathic system, may be contributing to the suppressive impact of the root tissue (i.e. alkenals and alkanols).

REFERENCES:

- (1) Angus JF, Gardner PA, Kirkegaard JA and Desmarchelier JM (1994). Biofumigation: Isothiocyanates released from *Brassica* roots inhibit the growth of the take-all fungus. *Plant and Soil*. 162: 107-112.
- (2) Drobnicka L., Zemanova M., Nemecek P., Antos K., Kristian P., Stullerova A., Knoppova V.m and Nemecek P., 1967. Antifungal activity of isothiocyanates and their analogues. *Appl.Microbiol.*15:701-3
- (3) Sarwar M., Kirkegaard J. A., Wong P.T.W. and Desmarchelier J M (1998). Biofumigation potential of brassicas. *Plant and Soil*. 201: 103-112.



Government
of South Australia