Field Pea Seed Residues: the Potential for Low Cost Weed Control

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Abstract

Plant growth suppression trials were undertaken with soil sampled 18 mo apart (2008, 2009) from two locations affected by field pea seed residues. Test plant species were grown in the residue-affected soil and compared to residue-unaffected soils, sampled from nearby fields. Germination was either fully inhibited or emergence delayed by more than one week in residue-affected soil. Dry matter accumulation of test species grown in residue-affected soil was significantly reduced compared to dry matter of these species grown in unaffected soil (P <0.0001). Canola and field pea were inhibited more than wheat and green foxtail over both years. Greenhouse trials also revealed that germination of wild oats was inhibited in the residue-affected soils, although overall, wheat and grassy weeds were less affected than dicots. Significant reductions of weed species diversity and abundance were correlated to residue-affected soils (P <0.0001) when compared to control soils using multi-response permutations procedures. In bioassays in sterile media, germination of wheat and canola seed was inhibited, using aqueous extracts of weathered pea seeds or extracts of the residue-affected soil. An allelopathic response was proposed to explain these results.

Objectives

- Assess plant growth (germination and early growth), using soil samples from the affected and adjoining normal sites (18 replicates, 2 locations [sampled June 2008 and October 2009]).
- Evaluate the plant growth suppression potential of field pea residues, using aqueous extracts of field pea (cv Delta) seed to screen for a growth suppression response in bioassays.
- Bioassay soil effects on plant growth using the affected soil as a water-soluble extract.

Materials and Methods

Greenhouse: soil residue effects on plant growth over 14 days (germination and emergence to at least the two-leaf stage) using normal and affected soil in trays (9 reps/site) (from 2 different soil sampling dates): wheat (cv AC Barrie), canola (Proven Seeds 9525, Viterra Inc.), green foxtail and field pea (cv CDC Striker).

Bioassays: germination and root elongation on media (MS basal salts + 0.3% sucrose in 2% agar, 150 mm Petri plates) of the test solutions; evaluated with wheat (AC Barrie) and canola over a 7-day period, incubated for 2 d at 20 ^{o}C followed by 5 d at 12 ^{o}C using the following:

- weathered pea seed extracts, applied to sterile filter paper disks in the centre to disperse into the media so as to act as a concentration gradient (tested at two concentrations, based on the original extract of water-soluble compounds from 52.4 g seed and a 1:10 dilution).
- soil extract: two concentrations: 3 mL (1.78 g^{-1} mL) affected soil and a 1:10 dilution, spread over the surface of the agar.
- control*:* sterile water blank, to compare germination and root elongation/shoot development on sterile media without test solutions.

Results and Discussion

Greenhouse: Germination was delayed, particularly in canola, grown on affected soils, compared to normal soil. Eventual growth of all test crops in affected soil was stunted. Dry matter biomass after 14-days was significantly different between the plants from affected and control soils at both locations (**Table 1**). Volunteer weed species (redroot pigweed, prostrate knotweed, sow thistle, green foxtail, lamb's quarters, kochia, wild buckwheat and stinkweed) flourished in control soil; weeds, other than round-leaved mallow, were repressed in the affected soils.

Bioassays: Wheat and canola did not germinate when exposed to field pea seed extracts; growth was retarded relative to the concentration of the extract (D, E, **Figure 1**). Undiluted extracts from the soil and the pea seed inhibited germination to a similar extent (B, D, **Figure 3**).

Diluted soil extracts (1:10) did not appear to affect germination and root elongation was not different from controls (A, C **Figure 1**).

Table 1: Greenhouse–grown plant response to soil from field pea residue samples.

Crop species	DM (mg) [a] Control soils	DM (mg) Affected soils	% DM[b]	$P_{0.05}$ [c]
Location 1				
Wheat	475.3	254.2	53.5	0.0001
Canola	252.9	37.9	15.0	< 0.00001
Green Foxtail	156.8	66.4	42.4	0.001
Field pea	719.6	439.7	61.1	< 0.00001
Location 2				
Wheat	557.2	418.9	77.0	0.0046
Canola	447.3	162.5	36.3	< 0.00001
Green Foxtail	206.7	113.0	54.7	0.0048
Field pea	719.5	498.6	69.3	< 0.00001

[a]Dry matter (average of 9 replicates); [b]inhibition compared to control soil; [c]significance (Student's t-test)

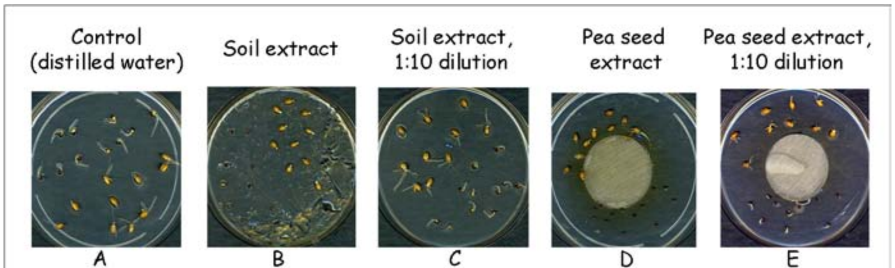

Figure 1: Plate bioassay – Day 7.

Conclusions

Greenhouse experiments with the soil from locations with field pea seed residues demonstrated that residue-affected soil had significant effects on germination and emergence. Since Location 1 has a longer history of use for stockpiling field pea, this may be reflective of a greater concentration of the putative allelopathic compounds accumulating over time. Crops grown on Location 2 soils were less affected than those tested on Location 1 soils. An allelopathic response is suggested, based on similar observations for other species[1].

Bioassay experiments with extracts of field pea seed represent an inhibitory response typical of an allelochemical [2, 3]. Results from assays of both soil and field pea extracts support evidence of a dilution effect, thereby suggesting that selectivity could be developed.

Future considerations

If the allelopathic effect is due to active compound(s) found to be part of the hulls, a valuable end use for a waste product could represent a value-added trait for this crop. A crucial question in this respect is to discover whether the active molecules derive from the hulls. An important long term goal is to identify the specific allelochemical(s) in field pea seed that exert growth suppression and to examine the role of soil microflora and environmental effects on the phenomenon. Economic weed management strategies could be developed with field pea seed residues. Innovative weed control techniques without recourse to expensive herbicides would then provide alternatives for sustainable agroecosytems.

References: [1]Perry et al. (2005) J. Chem. Ecol. *93*: 1126-1135. [2]Singh et al. (2003) Crit. Rev. Plant Sci. *22*: 239-311. [3]Blum et al. (1999) Crit. Rev. Plant Sci. *18*: 673-693.

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