

The Effects of Water Soluble Extracts from Wheat Straw on the Germination of Alfalfa

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Introduction

The establishment of alfalfa following wheat is sometimes met with difficulty. Seedlings growing in chalf rows appear weakened, chlorotic and unthrifty compared to those that emerge in areas of less chalf. Agronomists have speculated that the poor growth is a result of competition for nitrogen (N) sequestered by the carbon in the straw from the previous crop. Some have suggested that the chalf-rich soil dries out rapidly and may be a cause of poor seedling growth. Another contributing factor may be the effect of soluble substances leached from the wheat straw as it begins to decompose, termed “allelopathy”. Allelopathy has been defined as “the direct influence of a chemical released from one living plant (or plant residue) on the development and growth of another.

The scientific literature records the numerous accounts of allelopathy in cropping systems. Table 1 summarizes many of these relationships.

Table1. The allelopathic effect of plants on the germination and development of susceptible plants.

| <u>Plant inducing the effect</u> | <u>Plants and other organisms affected</u> |
|----------------------------------|---|
| Rice | Mono and dicotyledonous weeds |
| Tropical beans | Tomatoes, weeds, root-knot nematodes |
| Turnip, rape | Wheat, sowthistle, pigweed, barnyardgrass |
| Wheat | Perennial ryegrass, alfalfa , canola, rice, barley, rye |
| Perennial ryegrass | White clover |
| Alfalfa | Lettuce, clover seed, alfalfa |
| Jimsonweed | Sunflower |
| Corn | Rice, lettuce |
| Beets, oats, peas, barley | weeds |

There have been over 300 chemicals isolated that are believed to be involved. Most have the chemical properties of phenolics compounds. Table 2 lists some of these.

Table 2. Allelopathic compounds isolated from plants.

| Plant | Suspected compound(s) |
|--------------------|--|
| Corn | 2,4-dihydroxy-1,4-benzoxazin-3-one (DIOBA) |
| Sorghum | “sorgaab” and sorgoleone |
| Alfalfa | Medicarpin, sativan, coumarin, other phenolics |
| Perennial ryegrass | phytoalexins |
| Rice | p-hydroxybenzoic acid |
| Wheat | Phenolics acids, hydroxamic acids, 2,4-dihydroxy-7-methoxy-1,4-benzoxazin-3-one (DIMBOA) |

Soil microbes and plant pathogens interact with allelochemicals. The effects appear to be dosage dependent, and several allelochemicals may work in combination. Allelopathic effects include inhibited germination rate, darkened and swollen seeds, reduced root length, swollen or necrotic root tips, curling of the root axis and lowered reproductive capacity of affected plants.

Recent literature speaks to wheat and alfalfa in particular. I wanted to investigate whether commonly grown wheat varieties in the Columbia Basin could differ in their allelopathic effect on germinating alfalfa, and if so, find out if this is one reason why we sometimes see inconsistent germination and growth of alfalfa following wheat.

Materials and Methods

Samples of wheat straw of twelve varieties were hand-collected, dried and ground to a fine powder 1mm in size. The twelve varieties consisted of 10 soft winter wheats (“Masami”, “Cashup”, “WB528”, “WB788”, “Clearfirst”, “Stephens”, “Eltan”, “Bruell Club”, (“Madsen” and “Rod”), one hard red winter (“Declo”) and one hard red spring variety (“Express”). Ten of the samples were taken from yield trial plots south of Moses lake, WA. The sample of Rod was from a field near Warden, WA and the Masami sample was collected at the WSU Othello Research farm. Three and one-half grams of powder of each wheat sample were mixed with 30 ml of distilled water, shaken vigorously and let stand in the refrigerator at 40° F for 24 hours. The mixture was filtered through qualitative filter paper to eliminated fines. The extract was used to germinate “OK49” alfalfa. Distilled water was used as the control solution. Twenty surface-sterilized seeds were placed on filter paper in 9 mm petri dishes and allowed to germinate at 70° F for 72 hours at which time root length was measured and seeds that swelled but failed to germinate were counted.

Results

Death of seedlings and reduced vigor of seedlings as measured by root length are presented in Table 3. Significantly higher death of alfalfa seed was caused by extracts of the varieties Madsen, Express and Rod. Significantly reduced root growth was caused by straw extracts from Eltan, Bruell Club, Madsen, Express and Rod wheats. All wheats tended to cause some reduced growth of roots as compared to the distilled water check.

Table 3. The effects of wheat straw soluble extracts on the germination and root growth of OK49 alfalfa.

| <u>Extract Source</u> | <u>Root length (mm) @ 72 hr.</u> | <u>% Dead</u> |
|-----------------------|--------------------------------------|---------------|
| Distilled water | 21.5 | 8.3 |
| Masami (SSW) | 18.3 | 6.7 |
| Cashup (SSW) | 17.2 | 3.3 |
| Declo (HRW) | 16.8 | 3.3 |
| WB528 (SWW) | 15.5 | 3.3 |
| WB788 (SWW) | 15.2 | 0.0 |
| Clearfirst (SWW) | 14.9 | 0.0 |
| Stephens (SSW) | 14.2 | 8.3 |
| Eltan (SWW) | 10.1 | 15.0 |
| Bruell Club (SSW) | 9.1 | 13.3 |
| Madsen (SWW) | 7.1 | 18.3 |
| Express (HRS) | 7.3 | 21.7 |
| Rod (SWW) | 5.8 | 58.3 |
| Mean | 13.9 | 12.3 |
| Isd (.01) | 9.8 | 9.9 |
| CV% | 47 | 126 |

Discussion

Soluble extracts from some wheat causes reduced germination and depressed radicle growth of OK49 alfalfa. Because the wheat straw was not collected from all the same fields caution should be exercised when interpreting this data. The trial needs to be repeated with additional varieties of wheat sampled and more than one variety of alfalfa tested.

The data implies that the wheat variety preceding alfalfa may affect the establishment and growth of the new crop. Growers need to better manage wheat residues to reduce the allelopathic potential of the residues by removing straw through baling, or by immediately incorporating the straw. Growers should consider adding a nitrogen source and irrigation to begin the biological breakdown of the residue and to leach the soluble compounds from the straw, down into the lower root zone away from the site of germinating seeds soon after harvest to create a greater time-window before planting the alfalfa.

Wheat varieties with high levels of allelopathic potential may be wise choices for organic wheat producers to exploit the biological weed suppression of allelochemicals.