



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

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Introduction

The establishment of alfalfa following wheat is sometimes met with difficulty. Seedlings growing in chaff rows appear weakened, chlorotic and unthrifty compared to those that emerge in areas of less chaff. A 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”.

There have been over 300 chemicals isolated that are believed to be involved. Most have the chemical properties of phenolics compounds. For wheat, phenolic acids, hydroxamic acids, and 2,4-dihydroxy-7-methoxy-1,4-benzoxazin-3-one (DIMBOA) have been implicated.

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

I conducted experiments in both 2005 and 2006 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

2005:

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 white winter varieties (“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. Two grams of powder of each wheat sample were mixed with 25 ml of distilled water (80 g/l), shaken vigorously and let stand in the refrigerator at

40°F for 24 hours. The mixture was filtered through quantitative filter paper to eliminated fines. The extract was used to germinate “OK49” alfalfa. Distilled water was used as the control solution. Three replications of 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.

2006:

Water soluble extracts from 25 wheat varieties were tested on 3 alfalfa varieties and 6 weed species. The wheat varieties were sampled after the harvest of WSU and Cenex Harvest States cereal grain trials in Moses Lake, WA. They included “Rely”, “Hiller”, “Coda”, “Edwin”, “Bruehl Club”, “Lewjain”, “Eltan”, “Rod”, “Masami”, “Stephens”, “Tubbs”, “Cashup”, “Eddy”, “Declo”, “Paladin”, “Residence”, “Mayfair”, “Solano”, “Express”, “Finley”, “WB528”, “Mohler”, “Albion”, “Concept”, and “Madsen”. Madsen, Tubbs and Cashup were included twice as they occurred in multiple trials. Weed seeds tested included yellow foxtail, large crabgrass, barnyardgrass, redroot pigweed, hairy nightshade, kochia and white campion. The alfalfa varieties tested included OK 49, Pioneer 54Q25 and CW75046. Germination procedures were similar to that of 2005 except that the germination was conducted in a seed germinator set at 20° C with a 24 hour photoperiod. Instead of Petri dishes, seed was germinated in plastic boxes using germination paper. The extract resulted from mixing the ground wheat straw in distilled water at a rate of 166 g/l. Seedling growth and dead/damaged seed was scored at 4 days. To determine average seedling growth, seedlings were grouped based on vigor: (<10 mm), (10-20 mm), (20-30 mm), and (>30) mm and then counted within groups. Counts were subjected to the following equation: Avg. plant length = (n₁*5) + (n₂*15) + (n₃*25) + (n₄*40) where n₁₋₄ was the number of plants within each group and (5, 15, 20 and 40) are the average length of seedlings within respective groups. Seventy five seeds were germinated per replication, with three replications.

2005 Results:

Death of seedlings and reduced vigor of seedlings, as measured by plant length, are presented in Table 1. Significantly higher death of alfalfa seed were caused by extracts of the varieties Madsen, Express and Rod. Significantly reduced vigor was caused by straw extracts from Eltan, Bruell Club, Madsen, Express and

Table 1. The effects of wheat straw soluble extracts on the germination and vigor of OK49 alfalfa.

<u>Extract Source</u>	Plant length (mm) @ 72 hr.	% Dead Seed
Distilled water (check)	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

Rod wheats. All wheats tended to cause some reduced vigor as compared to the distilled water check.

2006 Results

Alfalfa:

When averaged over all wheat and alfalfa varieties, alfalfa germinated with straw extract solution resulted in a 15% reduction in seedling vigor and over twice the rate of dead or damaged seeds (Table 2). Alfalfa seedling growth ranged from 70% to 107% of the distilled water check based on wheat variety. Alfalfa varieties generally followed the same wheat variety effect. Because of space limitations, not all samples could be run at the same time, so three germination runs were conducted. Distilled water checks were included for each run.

Weeds:

Kochia was included in Run1. Of the 11 wheat extracted used, several significantly reduced the seedling vigor and seed viability of Kochia (Table 3). Straw extracts from wheat varieties Rod and Masami were used to germinate seeds of seven other weeds. Seedling vigor of white campion, redroot pigweed, crabgrass and black nightshade was reduced. Seedling vigor of lambsquarters and yellow foxtail was not affected. Barnyardgrass vigor was reduced by Masami extract but not by Rod. (Table 4).

<u>Wheat</u>	Seedling vigor (mm)	% Dead and damaged
Distilled water Check	31	17
Rely	27	39
Hiller	35	42
Coda	38	26
Edwin	34	41
Bruehl Club	31	55
Lewjain	31	39
Madsen	36	30
Eltan	30	48
Rod	25	42
Masami	24	72
Isd (.05)	3.4	12

Table 3. Seedling vigor of Kochia as affected by extracts of wheat straw.

Table 4. Vigor of weed seedlings germinated in wheat straw extracts from Rod and Masami expressed as percent of the distilled water check.

	White campion	Pigweed	Yellow foxtail	Crab-grass	Barnyard-grass	Black nightshade	Lambs-quarters	Isd (.05)
<u>Wheat</u>								
Masami	78	60	na	65	88	88	103	7
Rod	88	69	96	80	102	75	101	7

Conclusions and Discussion

Soluble straw extracts from some wheat varieties reduced germination and vigor of alfalfa and some weeds.

The data implies that the wheat variety preceding alfalfa may affect the establishment and growth of the new crop. Incorporated wheat straw may also provide some bio-control of weeds.

When trying to establish new alfalfa, growers need to better manage wheat residues to reduce the allelopathic potential of the residues by removing straw through baling, or by immediately enhancing the process straw breakdown by incorporation and irrigation. 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 and out of the upper root zone away from the site of germinating seeds.

Wheat varieties with high levels of allelopathic potential may provide weed suppression in organic wheat production.

Table 2. Alfalfa seedling vigor and viability as affected by germination using water soluble extracts from wheat straw.

	Wheat Variety	OK 49 Pio 54Q25 CW75046			Alfalfa Mean	Pio OK 49 54Q25 CW75046			Mean % Dead/damaged	OK 49 Pio 54Q25 CW75046			Alfalfa Mean	
		Mean. Plant Height (% of Check)				Mean% Dead & Damaged Seed				Dead/damaged %of CK				
Run 1	Rely	89	100	92	94	8	3	17	9	114	75	100	96	
	Hiller	84	82	72	79	13	4	14	10	186	100	82	123	
	Coda	87	78	80	82	6	1	16	8	86	25	94	68	
	Edwin	78	74	94	82	12	10	24	15	171	250	141	188	
	Bruehl Club	56	81	67	68	10	7	26	14	143	175	153	157	
	Lewjain	81	80	72	78	7	2	20	10	100	50	118	89	
	Madsen (1)	98	89	106	98	8	2	15	8	114	50	88	84	
	Eltan	87	67	99	84	11	5	20	12	157	125	118	133	
	Rod	68	56	90	71	11	7	15	11	157	175	88	140	
	Masami	80	67	77	75	9	7	38	18	129	175	224	176	
	Check Run 1	100	100	100		7	4	17	9	100	100	100	100	
Run 2	Tubbs (1)	78	76	62	72	8	2	9	6	114	67	180	120	
	Cashup (1)	90	77	83	83	6	9	5	7	86	300	100	162	
	Eddy	88	72	72	77	8	8	12	9	114	267	240	207	
	Declo	79	70	66	72	10	3	6	6	143	100	120	121	
	Paladin	92	67	65	75	6	2	5	4	86	67	100	84	
	Residence	85	62	62	70	7	3	17	9	100	100	340	180	
	Mayfair	81	67	67	72	10	5	11	9	143	167	220	177	
	Solano	82	61	73	72	9	4	8	7	129	133	160	141	
	Express	80	62	69	70	13	4	7	8	186	133	140	153	
		Check Run 2	100	100	100		7	3	5	5	100	100	100	100
Run 3	Finley	114	102	101	106	13	2	13	9	650	100	186	312	
	WB528	90	89	92	90	9	15	22	15	450	750	314	505	
	Mohler	97	94	98	96	11	3	23	12	550	150	329	343	
	Albion	104	100	102	102	15	9	17	14	750	450	243	481	
	Concept	107	100	107	105	16	9	15	13	800	450	214	488	
	Madsen (2)	102	102	104	103	15	10	22	16	750	500	314	521	
	Stephens	102	96	96	98	15	12	18	15	750	600	257	536	
	Tubbs (2)	103	96	102	100	13	9	20	14	650	450	286	462	
	Cashup (2)	106	97	102	102	13	6	13	11	650	300	186	379	
		Check Run 3					2	2	7	4				
		Overall means lsd (.05)	89	81	85	85	10	6	16	11	302	224	183	237 224