receiving payments for carbon stored in soils under high residue farming systems. Third, the issues surrounding hydroelectric power generation, salmon recovery, and urban growth will continue pressuring farmers to increase irrigation efficiency. Finally, a healthier farm economy, driven primarily by increased commodity prices resulting from corn-ethanol demand, provides farmers an opportunity to invest in equipment

Dry edible beans direct seeded into alfalfa

necessary to make the change.

Farmers who adopt high residue farming now will realize fuel savings and be better prepared for further fuel cost increases. By the time carbon credits become more widely available, these farmers will have had time to work out the kinks in their system. By proactively adopting more efficient water use practices, they potentially diffuse arguments to take away water due to inefficient use. Lastly, farmers who change now may still have willing buyers of tillage equipment which can be sold to offset the cost of upgrading to newer equipment required for high residue farming.

Harry Young Jr. planted his corn field over 45 years ago with the tools available to him. Today's tools are planters and drills designed to handle high amounts of residue; modern combines spread residue uniformly; and pre-emergent and post emergent herbicides, herbicide tolerant crops, seed treatments, and modern varieties produce yields Harry Young could only dream of in 1962. With new organic burn-down herbicides and specialized equipment for rolling down cover crops, even organic farmers can begin to consider these systems. The question today is not whether we have the tools to produce successful crops with high residue farming systems, the question is, "Why wait?"

WSU Extension and the Center for Sustaining Agriculture and Natural Resources have started a high residue farming program in the Grant-Adams area of the Columbia Basin. Visit their website for more information on production practices, pest management considerations, and educational activities.

Effect of Mustard Seed Meal on Early Weed Emergence in Peppermint and Potato

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Some of the pesticides discussed in this article were tested under an experimental use permit granted by WSDA. Application of a pesticide to a crop or site that is not on the label is a violation of pesticide law and may subject the applicator to civil penalties up to $7,500. In addition, such an application may also result in illegal residues that could subject the crop to seizure or embargo action by WSDA and/or the U.S. Food and Drug Administration. It is your responsibility to check the label before using the product to ensure lawful use and obtain all necessary permits in advance.

Seed meal is the by-product remaining after pressing or crushing mustard seed to remove the majority of the oil. While not widely available, it may become more available if biodiesel production increases and the economics of growing mustard improve in Washington.

Trials to evaluate weed suppression were conducted at several locations on peppermint and potatoes using seed meal obtained from a test crush of mustard seed, Sinapis alba, variety Ida Gold. Seed meal was donated by McKay Seed in Moses Lake, WA. Seed meal is typically in the form of irregular sized flakes and was run through a hammer mill to obtain a more uniform and spreadable granular material for these trials. ***Mustard seed meal is not an organically approved material for weed control.***

Peppermint

WSU Prosser site. Peppermint rhizomes/roots were dug and planted two to three inches deep in rows spaced 30 inches apart in a Warden sandy loam soil (1% O.M., pH 7.9) at WSU-IAREC August 10, 2006. Plots measured five feet by 10 feet with two rows of peppermint planted in each plot. Mustard seed meal was spread evenly over the entire soil surface by hand at 0.5, 1, and 2 ton/acre rates. Field pennycress (Thlaspi arvense) seed meal was also tested at the same three rates. Each treatment was replicated four times in a randomized complete block (RCB) design and was compared to an untreated weedy check and a terbacil (Sinbar) treated standard.

Seed meal treatments applied in field plots prior to planting potatoes.

White mustard seed meal reduced broadleaf and grass weeds at two weeks after transplanting but the two ton/acre rate provided the greatest weed control (Table 1). The number of weeds in the 0.5 and 1 ton/acre mustard meal treatments were similar to the untreated checks four weeks after transplanting, although the

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Table 1: Broadleaf Weed and Grass Density in Newly Planted Peppermint After Application of Two Seed Meals or Terbacil (Prosser, WA, 2006)

	Treatment	Rate (tons/acre)	Brdlf Weed Counts (no/plot)	Grass Weed Counts (no/plot)	Total Weed Counts (no/plot)	Brdlf Weed Counts (no/plot)	Grass Weed Counts (no/plot)	Total Weed Control (no/plot)	Brdlf Weed Control	Grass Weed Control	Peppermint Height (inches)
1	Nontreated Check		26.3 a	20.3 b	46.5 a	110 a	96.3 b	206.3 a	0 c	43.8 c	9.13 a
2	White Mustard Seed Meal	0.5	8.5 b	3.8 c	12.3 b	93.5 ab	101.8 b	195.3 a	32.5 c	58.8 b	9.13 a
3	White Mustard Seed Meal	1	6.8 b	2.8 cd	9.5 b	71.5 abc	63.3 bc	134.8 a	70 b	65 b	8.88 a
4	White Mustard Seed Meal	2	1.5 b	1.3 d	2.8 c	19.3 bc	27.5 c	46.8 b	71.3 b	73.8 b	10.13 a
5	Pennycress Seed Meal	0.5	13.8 ab	25.8 ab	39.5 a	82.5 ab	176 a	258.5 a	23.8 c	5 d	8.13 a
6	Pennycress Seed Meal	1	17.3 ab	45.5 a	62.3 a	71.5 abc	173.3 a	244.8 a	32.5 c	5 d	8.75 a
7	Pennycress Seed Meal	2	14.8 ab	61 a	75.8 a	77 abc	173.3 a	250.3 a	25 c	0 d	9.5 a
8	Sinbar (lb ai/acre)	0.5	0 b	0 c	0 d	0 c	0 d	0 b	100 a	99.8 a	8.38 a

1) Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls)

2) Grass counts and grass control data were transformed to meet homogeneity of variance requirements before performing ANOVA.

3) Broadleaf weeds consisted of common lambsquarters, henbit, common mallow, and pigweed. Grass weeds consisted of barnyardgrass and green foxtail.

4) White mustard seed meal obtained from McKay Seed in Moses Lake, WA. Field pennycress seed meal obtained from USDA-ARS lab in Peoria, IL.

weeds were smaller in the mustard meal treated plots. Plots treated with mustard meal at two ton/acre demonstrated significantly lower weed counts than the untreated check plots at four weeks after transplanting (Table 1). Phytotoxicity (chlorotic leaves) observed on several early emerged peppermint plants in two plots treated at two ton/acre of white mustard seed meal was short-lived and the peppermint grew normally thereafter.

Field pennycress seed meal applied at 0.5, 1, and 2 ton/acre did not reduce total weed emergence at two weeks after transplanting and tended to increase the number of grass weeds (Table 1). Grass weed counts at four weeks after transplanting were significantly greater in the plots treated with field pennycress seed meal compared to the untreated checks (Table 1). No peppermint injury was observed with field pennycress seed meal at any treatment rate. Field pennycress seed meal contains primarily glucosinolates that yield allyl isothiocyanate upon hydrolysis. This glucosinolate is very volatile and may be more effective in suppressing weeds when shallowly incorporated into the soil.

Weed control attained with the 1-ton rate of mustard meal in peppermint field plots.

Terbacil controlled nearly all weeds and only slightly injured peppermint (Table 1).

WSU Ephrata site. Peppermint rhizomes/roots were dug and broadcast planted on two certified organic commercial fields on March 16 and April 14 of 2006. Stolons were planted approximately one to two inches deep. Plots were 1.5 feet by 10 feet and mustard seed meal was spread evenly over the entire soil surface by hand at 0.5, 1, 1.5, and 2 ton/acre rates. In the first trial, mustard meal was applied March 16 and weeds counted April 17, 2006. In the second trial, seed meal was applied May 5th after flaming and weed seedlings were counted May 16, 2006. Each treatment was replicated six times in a RCB design and an untreated check was included for comparison. The weeds in untreated plots were mainly pigweed, whereas common lambsquarters were the dominant weed in the treated plots. No grass weeds were present in these trials.

In the first trial, white mustard seed meal reduced the number of weed seedlings by 65% at the 0.5 ton/acre treatment rate and over 90% when treated with one ton/acre or higher of seed meal (Table 2). In the second trial, all rates of seed meal reduced early weed counts by 74% or more (Table 2). Phytotoxicity (chlorotic leaves) observed on peppermint plants that emerged through white mustard seed meal was short-lived and the peppermint grew normally thereafter.

Potato

Umatilla potatoes were planted near Paterson, WA March 31, 2006, on a Quincy sandy soil containing 0.4% organic matter. After dragging the tops of the hills with a rod weeder on April 24, Mustard seed meal was applied the next day in a 12 inch band on the potato hill at 0.5, one,

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Table 2: Broadleaf Weed Density in Newly Planted Peppermint After Application of Mustard Seed Meal (Ephrata, WA, 2006)

Treatment		Rate (tons/acre)	Trial 1 Brdlf Weed Counts (4/17/06)	Trial 2 Brdlf Weed Counts (5/16/06)
1	Nontreated Check		20.5 a	11.4 a
2	White Mustard Seed Meal	0.5	7.3	3 b
3	White Mustard Seed Meal	1	1.8 c	1.4 b
4	White Mustard Seed Meal	1.5	1.1 c	0.4 b
5	White Mustard Seed Meal	2	1.1 c	0 b

1) Means followed by same letter do not significantly differ (P=.05, LSD test)
2) Broadleaf weeds consisted of pigweed and common lambsquarters.
3) White mustard seed meal obtained from McKay Seed in Moses Lake, WA.

and two tons/acre (in the treated band area). Dried distillers grain (DDGS), a by-product of ethanol produced from corn, was also tested at one ton/acre and a untreated check was included. Plots were two rows by 20 feet and treatments were replicated four times. Small emerging weeds in the furrows were controlled by dammer diking on May 18 after potatoes had emerged. The main weeds present included hairy nightshade, large crabgrass, and lesser amounts of redroot pigweed. Weeds were counted from four, 1.1 ft^2 areas in the hills of each plot on May 16, three weeks after transplanting. Final weed counts and dry weights were taken on August 21. Potato tubers were dug with a one-row harvester and size graded on August 29.

Mustard seed meal at 0.5 ton/acre did not reduce the number of weeds compared to the untreated check, but rates of one and two ton/acre significantly reduced counts of large crabgrass and total weed emergence (Table 3). Dried distillers grains applied at one ton/acre increased hairy nightshade counts and total weed counts at three weeks after transplanting (Table 3). Plots treated with mustard seed meal at two tons/acre reduced final weed density (five weeds per square meter) when compared to 48 and 50 weeds per square meter in untreated checks and plots treated with distillers grain, respectively. Final weed dry weight was similar among all treatments, except the two tons/acre mustard meal treatment, which reached only 13% of the untreated checks.

Potato tuber yield or specific gravity were not statistically significantly different among treatments, but untreated checks and plots treated with dried distillers grain, averaged the lowest yields (Table 3).

Table 3. Total Weed Counts Following Mustard Seed Meal or Dried Distillers Grain Application (Paterson, WA ,2006)

Treatment		Rate (lbs/acre)	Hairy Nightshade 5/16/06	Large Crabgrass 5/16/06	Total Weed Count 5/16/06	Potato Yield 9/11/06	Potato Specific Gravity 9/11/06
1	Nontreated Check		17.8 abc	14.8 b	38.5 b	26.9 a	1.08 a
2	White Mustard Seed Meal	0.5	24.5 ab	8.5 bc	37 b	30.9 a	1.09 a
3	White Mustard Seed Meal	1	7.8 bc	3.8 c	15 c	31.8 a	1.08 a
4	White Mustard Seed Meal	2	2.8 c	1.8 c	5 d	29 a	1.08 a
5	Dried Distillers Grain	1	45 a	24.3 a	78.3 a	25.6 a	1.09 a

1) Means followed by same letter do not significantly differ (P=.05, Student-Newman-Keuls).
2) Weeds consisted of hairy nightshade, redroot pigweed, large crabgrass, and common lambsquarters.
3) White mustard seed meal came from McKay Seed in Moses Lake, WA. Dried distillers grain came from Big River Resources, LLC, 15210 103rd St., West Burlington, IA 52655.

Discussion

Mustard seed meal formed a crust on the soil surface when sprinkler irrigated 0.25 inches soon after application. High winds or heavy irrigation immediately after treatment application could redistribute granules and leave unprotected areas. A reliable method of spreading seed meal uniformly in the field is necessary to obtain consistent weed control. Weed control appears to be short-lived, lasting between two to four weeks after application. If timed properly, it could be used in conjunction with other weed control practices (e.g., flaming, cultivation, hand-weeding) or timed so that the crop could shade out later emerging weeds.

White mustard seed meal appears most effective for suppression of small-seeded annual weeds when applied preemergence at rates of one ton or more to the soil surface. The high cost of material and spreading likely limits practical uses of mustard seed meal for weed control to high value or organically grown crops. In greenhouse trials, mustard seed meal inhibits emergence of redroot pigweed and kills many emerged small seedlings in the cotyledon stage. In other trials, mustard seed meal applied to surface of perennial potted ornamentals appears promising for annual weed control in ornamentals. If this material is marketed or recommended for the purpose of controlling weeds, it would first have to be registered with EPA as pesticide.