CALIFORNIA LETTUCE RESEARCH BOARD
April 1, 2005 – March 31, 2006

Title: Mustard Cover Crops to Optimize Crop Rotations for Lettuce Production

Project Investigators: Richard Smith, and Steve Koike, UCCE, Monterey County
Krishna Subbarao and Steve Fennimore, University of California

SUMMARY

Effective rotations are an essential part of lettuce production. Unfortunately, given economic pressures such as high land rents and lower returns for rotational crops, effective rotations are not always possible. As a result, Lettuce Drop caused by *Sclerotinia minor*, has become the key soilborne disease in the Salinas Valley. Growers in the Salinas Valley and other areas plant mustard cover crops (*Brassica and Sinapis spp.*) as a rotational because they contain glucosinolates that, upon incorporation into the soil, breakdown to isothiocyanates which biofumigate the soil. Our evaluations over the past three years indicate that mustard cover crops provide limited control of some weed species (Smith 2004) but have little to no impact on soil sclerotia abundance or on *S. minor* infection of subsequent lettuce crops (Smith et al 2005). The lack of definitive impact on mustard cover crops on *S. minor* may be due to the small amount of isothiocyanates that they contain. Based on positive results from studies of other mustard species in Australia , we changed the focus of the mustard cover crop evaluations for this funding cycle and initiated examinations of the impact of a different mustard variety, BQMulch, on soilborne pests of lettuce. According to previous work as well as our measurements this year, BQMulch (*B. napus* and *B. rapa*) has high glucosinolate content and contains a larger percentage of glucosinolates in the root tissue. It is hypothesized that the glucosinolates in the roots may be more efficiently incorporated into the soil and less subject to volatilization. Sclerotinia evaluations are underway as of this writing; weed evaluations at the thinning stage of lettuce show no improvement in weed control with BQMulch. These conclusions are based on a single season thus far but the effects of these cover crops over the longer term remains to be determined.

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Objective. To evaluate the level of control of lettuce drop and weeds that can be provided by BQMulch (*Brassica napus*) in lettuce rotations.

PROCEDURES AND RESULTS:

Procedures: ***2003 – 2005 Long-term trial (not previously reported):*** Five cover crop treatments (see Table 1) were evaluated over the winters of 2003-04 and 2004-05. Following incorporation of the cover crops, two crops of head lettuce were planted. Soil sclerotia, Sclerotinia infection on the lettuce and yield were evaluated. ***Short-term plots:*** Four short-term field evaluations were conducted in 2005-06. Two trials were conducted in grower's fields (trials 1 & 2) that included 2-3 acre strips of BQMulch (combination of *B. napus* and *B. rapa*) in a field planted adjacent to Caliente 99 (combination of two *B. juncea* varieties). Three bare fallow strips of 45' x 45' were left as an untreated control in each trial. The mustards were evaluated for biomass production and glucosinolate content of the tops and roots of the plants. In trials 2 and 4 the *B. napus* and *B. rapa* components of BQMulch were analyzed separately to determine their individual contribution. Lettuce was planted several weeks following incorporation of the mustard cover crops and was evaluated for Sclerotinia infection and weed control. Trials 3 and 4 were conducted at the Hartnell East Campus and Spence USDA Station, respectively, to compare the biomass and glucosinolate content of BQMulch and other mustard varieties. ***Long-term plot:*** A long-term cover crop rotation trial was established at the Hartnell East Campus Research Facility at a site with a high count of Sclerotia. The first cover crop cycle was grown in the winter of 2005 – 2006. Soil sclerotia were counted following planting and soil samples were collected to monitor the impact of the treatments on the soil seed bank. As of this writing the subsequent lettuce crop has just been planted. ***Glucosinolate Analyses:*** Glucosinolate samples were collected at cover crop maturity. Cover crop tops were carefully collected and immediately frozen with dry ice. Samples were freeze-dried at the Dept. of Animal Science at UC, Davis and then shipped to the University of Idaho for glucosinolate analysis. Glucosinolate content of the plants were converted to methy isothiocyanate content (the active ingredient of metam sodium - Vapam®) to determine their relative biofumigation potential.

Results: ***2003 – 2005 Long-term trial:*** Results from the 2003 to 2005 long-term mustard cover crop trial were presented in prior reports, but these complete results were not available for the 2005 report and are presented here. Mustard cover crops had no effect on soil sclerotia over the two years of the trial (Tables 1 & 2). There was no effect of mustard cover crops on the levels of infection of lettuce by *S. minor* in 2004, but on the second lettuce crop in 2005, there was greater *S. minor* infection in the second lettuce crop in the Indian mustard plot while Merced rye had the lowest level of infection. It was observed that Indian mustard is susceptible to *S. minor* infection and may have contributed increased *S. minor* infection on lettuce. Cover crops improved the yield of lettuce in the first lettuce crop but not in the second in both 2004 and 2005. ***Short-term plots:*** *Trial No. 1:* There were more weeds in the BQMulch plots than the bare (Table 3). It was noted by the cooperating growers that BQMulch has a strong tendency to resprout from roots following incorporation. The first Sclerotinia evaluation was conducted on May 16, but no infection was observed at the midgrowth stage of the planting. There were significantly fewer lettuce plants in the BQMulch than the Caliente 99 or bare treatments prior to thinning. *Trial No. 2:* Weed populations were low in this field and no significant differences were observed between treatments (Table 3). The lettuce plants were too immature as of this writing to evaluate *S. minor* infection. Biomass comparisons of BQMulch and other mustards indicate that even though it is low-growing it is as productive as other commonly used mustard cover crops (Table 4 & 5). ***Long-term plot:*** The cover crops were grown and incorporated but the lettuce was not planted at the time of this writing. ***Glucosinolate Analyses:*** Glucosinolate analyses indicate that varieties of *B. napus* and Caliente 99 contained higher amounts of glucosinolate in the roots than other varieties tested (Table 4). Total glucosinolate content of individual varieties is dependent on the glucosinolate concentration and biomass production, and varied by variety and site (Table 5). These trials indicate that there are specific varieties that have higher glucosinolate content in their roots, but the total glucosinolate content was still relatively low in comparison with commercial application rates of Vapam (37.5 – 75.0 gal/A).

Table 1. Summary of soil sclerotia, lettuce drop incidence and yield of lettuce 2004

Cover Crop Treatments	Spring Lettuce Crop						Summer Lettuce Crop			
	Soil Sclerotia pre cover crop Aug. 28, 03 (No./100 g soil)	Soil Sclerotia post cover crop Nov. 6, 03 (No./100 g soil)	Sclerotinia infection on lettuce At harvest April 27, 04 (percent)	Yield uncut heads (percent)	Yield (tons/acre)	Mean Head Wt (pounds)	Soil Sclerotia Early lettuce July 9, 04 (No./100 g)	Sclerotinia infection on lettuce At harvest Aug. 30, 04 (percent)	Yield uncut heads (percent)	Soil Sclerotia post lettuce Aug. 31, 04 (No./100 g soil)
Cereal Rye ‘Merced’	1.6	1.2	1.83	13.9	21.80	1.47	2.0	0.8	53.8	2.6
Broccoli ‘DiCicco’	2.6	3.0	2.68	16.2	21.60	1.47	2.4	1.0	50.6	4.3
White Mustard ‘Ida Gold’	2.2	1.5	2.65	16.2	21.43	1.42	2.1	1.0	44.9	3.9
Indian Mustard ‘ISCI 61’	0.7	7.3	2.34	14.0	22.33	1.53	1.9	1.0	37.8	3.9
Bare Fallow	1.5	2.2	2.55	27.3	19.37	1.32	1.9	0.7	58.8	5.0
LSD (0.05)	*NS*	NS	*NS*	6.3	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*

Table 2. Summary of soil sclerotia, lettuce drop incidence and yield of lettuce 2005

Cover Crop Treatments	Spring Lettuce Crop					Summer Lettuce Crop				
	Soil Sclerotia Feb 10, 05 (No./100 g soil)	Sclerotinia infection on lettuce At harvest June 20, 05 (percent)	Yield uncut heads (percent)	Yield (tons/acre)	Mean Head Wt (pounds)	Soil Sclerotia Oct 18, 2005 (No./100 g soil)	Sclerotinia infection on lettuce At harvest Oct 4, 05 (percent)	Yield uncut heads (percent)	Yield (tons/acre)	Mean Head Wt (pounds)
Cereal Rye ‘Merced’	3.33	1.0	23.55	32.52	2.18	3.6	2.6	51.4	21.1	1.47
Broccoli ‘DiCicco’	4.22	2.2	21.28	32.15	2.11	5.8	4.1	35.8	21.6	1.50
White Mustard ‘Ida Gold’	3.33	1.5	18.72	34.50	2.26	6.3	4.9	40.0	22.1	1.48
Indian Mustard ‘ISCI 61’	4.33	1.5	14.65	34.32	2.22	8.8	5.6	54.1	22.1	1.46
Bare Fallow	3.56	1.9	23.97	30.98	2.08	3.9	3.5	53.7	20.8	1.40
LSD (α=0.05)	NS	0.4 (α=0.1)	NS	0.80	0.10	NS	1.5	NS	NS	NS

Table 3. Trials No. 1 & 2. Weed evaluations and stand count at thinning stage

Cover Crop Variety	Trial No. 1. Weeds per 37.5 ft^2 on April 19, 2006							Trial No. 2. Weeds per 22 ft^2 on May 16, 2006					
	Groundsel	Sow Thistle	Pineapple Weed	Mustard	Other Weeds	Total Weeds	Lettuce Stand Count No./25 ft	Shepherd's Purse	Purslane	Nettle	Mustard	Other Weeds	Total Weeds
BQ Mulch	11.9	2.7	31.1	1.6	0.9	48.1	193.8	4.7	0.2	0.2	0.1	0.1	5.3
Caliente 99	3.7	0.7	14.8	0.0	1.7	20.8	218.4	2.4	0.5	0.4	0.1	0.3	3.8
Bare	7.6	1.0	6.4	0.1	1.0	16.1	231.6	3.7	0.2	0.5	0.0	0.6	5.4
LSD	6.1	ns	ns	1.5	ns	5.0	23.7	ns	ns	ns	ns	ns	ns

Table 4. Summary of total biomass, root biomass, glucosinolate content and Vapam equivalent of mustards in short-term mustard cover crop trials

Cover Crop Variety	Aboveground Biomass (tons/acre)	Total Biomass (tons/acre)	Percent Roots of Total Biomass	Total Glucosinolate Content (µmole/g)		Vapam Equivalent (Gals/A)
				Tops	Roots	
BQ Mulch (*B. napus & B. rapa*)	2.89	3.61	18.99	20.0	26.0	2.02
Pacific Gold (*B. juncea*)	2.68	3.56	25.33	15.1	4.5	1.59
Ida Gold (*Sinapis alba*)	3.46	4.16	17.21	21.6	7.4	3.26
Caliente 61 (*B. juncea*)	4.34	5.24	17.73	16.3	5.4	3.09
Caliente 99 (*B. juncea*)	2.96	3.58	17.98	17.1	16.6	2.51
Erica (*B. napus*)	3.44	4.25	19.18	10.5	17.7	2.31
Humus (*B. napus*)	3.22	4.29	25.63	25.7	25.8	4.06
Merced Rye (*Secale cereale*)	1.82	1.82	N/A	N/A		N/A
LSD (0.05)	*0.49*	*0.47*	4.96	*5.6*	*9.0*	1.74

Table 5. Total biomass, root biomass, glucosinolate content and Vapam equivalent of mustard cover crops in four short-term trials

Trial	Cover Crop Variety	Aboveground Biomass (tons/acre)	Total Biomass (tons/acre)	Percent Roots of Total Biomass	Total Glucosinolate Content (µmole/g)		Vapam Equivalent (Gals/A)
					Tops	Roots	
Trial No. 1	BQ Mulch	2.08	2.54	21.9	21.2	30.1	2.50
	Caliente 99	1.96	2.49	27.8	14.7	22.8	1.88
	LSD (0.05)	*ns*	*ns*	*ns*	*3.0*	*5.6*	*ns*
Trial No. 2	BQ Mulch	3.20	3.69	13.3	16.3	36.2	1.39
	B. rapa	1.65	1.85	9.8	20.3	36.1	1.23
	B. napus	1.56	1.85	15.6	13.1	36.2	1.59
	Caliente 99	3.06	3.51	12.8	12.8	21.5	1.95
	LSD (0.05)	*ns*	*ns*	*ns*	*ns*	*9.1*	*ns*
Trial No. 3	BQ Mulch	2.14	2.39	10.4	17.3	10.5	1.65
	Pacific Gold	1.62	1.96	17.8	19.5	4.1	1.34
	Ida Gold	2.47	2.76	10.7	19.7	9.7	2.08
	Merced Rye	1.85	N/A	N/A	N/A	N/A	
	LSD (0.05)	*0.53*	*0.47*	*3.2*	*ns*	*ns*	*ns*
Trial No. 4	BQ Mulch	4.19	5.59	20.6	23.8	17.8	2.54
	B. rapa	1.26	1.89	35.1	23.3	18.4	1.69
	B. napus	2.94	3.70	20.6	24.4	17.2	3.40
	Pacific Gold	3.75	4.75	21.2	10.7	4.9	1.84
	Ida Gold	4.45	5.24	15.0	23.5	5.2	4.45
	Caliente 61	4.34	5.30	18.5	16.3	5.4	3.09
	Caliente 99	4.14	5.12	19.2	26.0	5.5	3.89
	Erica	3.44	4.64	26.0	10.5	17.7	2.31
	Humus	3.22	4.40	27.2	25.7	25.8	4.06
	LSD (0.05)	*0.72*	*0.78*	*6.1*	*3.7*	*4.4*	*ns*