Weed Control

Mengmeng Gu
Section Editor and Moderator

Effect of spent coffee grounds on germination of palmer amaranth, perennial rye, and white clover

Diana R. Cochran[1], Patricia R. Knight[2], and Mengmeng Gu[1]
[1]117 Dorman Hall, Mississippi State University, Mississippi State, MS 39762
[2]Coastal Research and Extension Center, Mississippi State University, Biloxi, MS 39532

Index Words: coffee residue, coffee, organic weed control

Significance to Industry: Spent coffee grounds (SCG), are the coffee residues after the brewing process, which are considered municipal solid waste and normally end up in landfills. There is a vast amount of SCG available locally and from the bottled and canned coffee manufactures. Many coffee shops across the United States have programs where they give free SCG to their patrons making SCG a low cost by-product available for the green industry.

Nature of Work: In 2005, individuals consumed 24.2 gallons of coffee per year in the United States alone (2). While this per capita is based on liquid consumption it does not account for the solid waste or coffee residue after the brewing process. It is estimated that the daily volume of coffee residue is 0.91 kg for each kilogram of soluble coffee (12). In 2006/2007 world coffee production was estimated at 134.3 million bags, over 8 billion kg (9).

Previous research has suggested that SCG can be used as alternative fuels (8), soil additives (12), metal adsorbents (10), vermicompost (6), landscape compost (5), mulch (4), and organic weed control (7). Morikawa and Saigusa (5) composted SCG with ferrous sulfate for 60 days in plastic bags. Their findings showed that this compost combination decreased pH in alkaline soils, increasing plant available Fe. Additionally, mulching with coffee husk has shown to conserve soil moisture enough to significantly promote vegetative growth in pineapples when moisture is a limiting factor (4). Subsequently, coffee husk mulch had 85.5% weed control compared to the non-weeded/non-mulched control. Studies conducted by Sciarrappa et al., (7) showed that mulching with SCG to a depth of 1.6 – 3.1” provided 95% weed control in organic blueberry production.

Local Starbucks® coffee shops in Starkville, MS provided SCG. Experiment 1 - Effect of aqueous coffee extract (ACE) on seed germination. Treatments included 4 concentrations of ACE and reverse osmosis water (RO) was used as control. Stock ACE was developed by mixing 231 g of spent coffee grounds with 600 mL of water and stirring for 48 hours on a stirrer plate (Corning Stirrer/Hotplate). The coffee solution (pH5.39, EC1.69 dS/m) was then filtered through cheese cloth. The ACE of various concentrations were formulated in 100 mL beakers as following: 25 % ACE consisted of 10 mL of the stock ACE and 30 mL of RO, 50 % consisted of 20 mL of stock ACE and 20 mL of RO, 75 % consisted of 30 mL of stock ACE and 10 mL of RO, and 100 % was

40 mL of stock ACE. Captain fungicide was added to each treatment based on recommended label rate of 1 ½ tbs/gal (0.088 g/40 mL). Whatman® #1 filter paper was placed on the Petri dishes. Four mL of solution was added to each Petri dish to saturate the filter paper and 25 seed of *Amaranthus palmeri* (palmer amaranth), *Lolium perenne* (perennial rye), and *Trifolium repens* (white clover) were placed in one Petri dish (3 species, 25 seed per plate). There were five Petri dishes for each of the four ACE treatments and the control, and there were a total number of 25 Petri dishes in the experiment. All Petri dishes were placed in a growth chamber with 20°C/15°C (day/night temperatures) and 16 hour photoperiod. Petri dishes were monitored daily, adding an additional mL of the corresponding ACE solution to each plate as needed to keep seeds from drying out. Data included the germination rate and germination development (white clover only presence of radicle, 1 leaf cotyledon, 2 leaf cotyledon). A seed was considered germinated once visible change in the seed was noticed (e.g. break in seed coat, radicle emerging).

Experiment 2 - Effect of SCG and pine bark (PB) on seed germination in containers. Trade gallon containers were filled with Sunshine #1 potting mix to 3” below the top of the container and watered accordingly. White clover were overseeded at 15 seed per container (one species per container) and then mulched with either SCG or PB to a depth of 0, 0.5, 1.0, 1.5 or 3” and watered accordingly. Data collected included the number of visible weeds at 3, 6, 10, 14 and 28 days after seeding (DAS) and shoot dry weight 28 DAS. Containers without SCG or PB were used as controls. Data were analyzed utilizing SAS 9.2 generalized linear model, with mean separation according to least significant difference test, alpha = 0.05.

Results and Discussion: Experiment 1 – White clover started germinating in all treatments 1 DAS (Table 1) and the 75 % ACE had statistically less white clover germination (22 %) compared to the control (17%). At 2 and 4 DAS all ACE-treated dishes had less germination compared to the control. At 5 DAS, all ACE treatments had less white clover germination compared to the control except the 25 % ACE treatment. Seven DAS all ACE treatments had similar white clover germination compared to the control exception the 100 % ACE solution. By 8 DAS nearly all white clover had germinated in all treatments and were statistically similar. While statistically there were no differences in treatments at 8 DAS, there were visual differences. As the percentage of ACE increased, the progression of seed growth was less advanced (Table 2). At 9 DAS, 77 % of the seed treated with 75 and 100 % ACE only had emerged radicles. Only 3 % of the seed had 1 or 2 cotyledons in 100 % ACE treatment. On the other hand, 14 % of the seed were in the 1 leaf cotyledon stage and 38 % in 2 leaf cotyledon stage for the control.

Perennial rye seed started germinating 4 DAS in the 0, 25 and 50% ACE treatments (Table 3). However there were no significant differences regardless of ACE treatments. At 6, 7, and 8 DAS all treatments with ACE had significantly less perennial rye than the control. The number of germinated perennial rye seeds tended to decrease as the percentage of ACE increased, respectively.

Palmer amaranth treated with higher percentage of ACE had lower seed germination rate than the control (Table 4). However, germinated seed was short lived, more than likely due to the small seeds being over saturated.

Experiment 2 - For white clover there was significantly less seedlings in all treatments with mulch than the control regardless of the depth or type (Table 5). Our results were similar to Sciarappa et al. (7) who reported that mulching with SCG is an effective weed control option in field blueberry production. Comparing mulch types, 0.5 and 1.0" SCG were not significantly different from 0.5 and 1.0" PB treatments, respectively. At 14 DAS white clover started emerging in the 1.5" PB treatment, however statistically there is no difference compared to the zero emergence in 1.5" SCG treatment. No weed emergence was observed in 3" SCG or PB mulch. As of 14 DAS only a few of palmer amaranth had only germinated in the 0" mulch (data not shown).

In conclusion, initial white clover germination was observed in all ACE treatments however development of the seedlings at 8 DAS were different, respectively. These results suggest that ACE might have some properties that inhibit white clover and perennial rye growth. Mulching with either SCG or PB had less seedlings than the non-mulched treatment. Moreover, mulching in containers is a technique used by Oregon growers especially in areas or crops susceptible to herbicide damage (1). Utilizing SCG as mulch in containers can provide an organic alternative to weed control in the container nursery industry. These results are ongoing and future research will focus on evaluating container plant growth with SCG mulch and evaluating SCG as a weed barrier.

Literature Cited:

1. Altland, J. and M. Lanthier. 2007. Influence of container mulches on irrigation and nutrient management. J. Environ. Hort. 25:234-238.
2. Buzby, J.C. and S. Haley. 2007. Coffee consumption over the last century. USDA. http://www.ers.usda.gov/AmberWaves/June07/Findings/Coffee2.htm. Accessed on August 26, 2010.
3. Contreras, E.P. M. Sokolov, G. Mejia, and J.E. Sanchez. 2004. Soaking of substrate in alkaline water as a pretreatment for the cultivation of *Pleurotus ostreatus*. J. Hort. Sci. Biotech. 79:234-240.
4. Eshetu, T., W. Tefera, and T. Kebede. 2007. Effect of weed management on pineapple growth and yield. Eth. J. Weed Mgt. 1:29-40.
5. Morikawa, C.K. and M. Saigusa. 2008. Recycling coffee and tea wastes to increase plant available Fe in alkaline soils. Plant Soil 304:249-255.
6. Orozco, F., J. Cegarra, L. Trujillo, and A. Roig. 1996. Vermicomposting of coffee pulp using the earthworm *Eisenia fetida*: Effects on C and N contents and the availability of nutrients. Biol. Fertil. Soils 22:162-166.
7. Sciarappa, W., S. Polavarapu, J. Barry, P. Oudemans, M. Ehlenfeldt, G. Pavlis, D. Polk, and R. Holdcraft. 2008. Developing an organic production system for highbush blueberry. HortSci. 43:51-57.

8. Silva, M.A., S.A. Nebra, M.J. Machado, and C.G. Sanchez. 1998. The use of biomass residues in the Brazilian soluble coffee industry. Biomass Bioenergy 14:457-467.
9. United States Department of Agriculture. 2007 Tropical products: World markets and trade. http://www.fas.usda.gov/htp/tropical/2007/June%202007/June%20Tropical.pdf. Accessed on August 28, 2010.
10. Utomo, H.D. and K.A. Hunter. 2006. Adsorption of divalent copper, zinc, cadmium and lead ions from aqueous solution by waste tea and coffee adsorbents. Env. Tech. 27:25-32.
11. Woods, T. 2008. Trained composters perk up ground with coffee grounds. OSU Extension. http://extension.oregonstate.edu/news/story.php?SNo=545&storyType=news. Accessed on August 29, 2010.
12. Yen, W., B. Wang, L. Chang, and P. Duh. 2005. Antioxidant properties of roasted coffee residues. J. Agric. Food Chem. 53:2658-2663.

Table 1. Effect of aqueous coffee extract (ACE) concentations on germination of *Trifolium repens* .

		Germination rate (%)						
Treatment	ACE	1 DAS[z]	2 DAS	4 DAS	5 DAS	6 DAS	7 DAS	8 DAS
1	0%[y]	17 a[x]	35 a	56 a	60 a	73 a	85 a	82 a
2	25%	10 ab	17 b	36 b	52 ab	61 ab	84 ab	80 a
3	50%	9 ab	18 b	26 bc	37 bc	58 ab	83 ab	86 a
4	75%	3 b	8 b	17 c	26 c	62 ab	82 ab	83 a
5	100%	7 ab	13 b	22 c	36 c	44 b	49 b	77 a

[z]DAS = days after seeding.

[y]Percentage of the ACE stock solution. The stock solution was obtained by mixing 231 g of coffee grounds with 600 mL of water and stirring for 48 hours on a shaker plate.

[x]Means within a column with the same letters are not significantly different, according to least significant difference test (α=0.05).

Table 2. Differences in *Trifolium repens* grown under aqueous coffee extracts (ACE), 9 days after seeding.

		Seed germination development (%)					
Treatment	ACE	Radicle[z]		Cotyledon[y]		Leaf[x]	
1	0%[w]	32.0	b[v]	14.4	a	37.6	a
2	25%	52.0	ab	8.8	ab	27.2	ab
3	50%	64.8	a	12.0	a	12.0	bc
4	75%	76.8	a	8.0	ab	6.4	bc
5	100%	76.8	a	3.2	b	3.2	c

[z]Radicle = only the radicle had emerged.

[y]Cotyledon = 1 leaf cotyledon stage.

[x]Leaf = 2 leaf cotyledon stage.

[w]Percentage of the ACE stock solution. The stock solution was obtained by mixing 231 g of coffee grounds with 600 mL of water and stirring for 48 hours on a shaker plate.

[v]Means within a column with the same letters are not significantly different, according to least significant difference test (α=0.05).

Table 3. Effect of aqueous coffee extract (ACE) concentations on germination of *Lolium perenne* .

		Germination rate (%)													
Treatment	ACE	1 DAS[z]		2 DAS		4 DAS		5 DAS		6 DAS		7 DAS		8 DAS	
1	0%[y]	-		-		2	a[x]	10	a	32	a	43	a	52	a
2	25%	-		-		1	a	4	a	11	b	24	b	28	b
3	50%	-		-		1	a	1	a	8	b	18	bc	28	b
4	75%	-		-		0	a	0	a	3.2	b	10	cd	15	bc
5	100%	-		-		0	a	0	a	0	b	0.8	d	3.2	c

[z]DAS = days after seeding.

[y]Percentage of the ACE stock solution. The stock solution was obtained by mixing 231 g of coffee grounds with 600 mL of water and stirring for 48 hours on a shaker plate.

[x]Means within a column with the same letters are not significantly different, according to least significant difference test (α=0.05).

Table 4. Effect of aqueous coffee extract (ACE) concentations on germination of *Amaranthus palmeri* .

		Germination rate (%)						
Treatment	ACE[z]	1 DAS	2 DAS	4 DAS	5 DAS	6 DAS	7 DAS	8 DAS
1	0%[y]	1 a[x]	6 a	18 a	27 a	14 a[w]	24 ab	20 a
2	25%	2 a	6 a	8 b	13 b	9.6 a	29 a	14 a
3	50%	1 a	3 a	10 ab	6 b	10 a	8.8 ab	7.2 b
4	75%	2 a	2 a	2 b	6 b	5.6 a	4 b	8 b
5	100%	3 a	2 a	4 b	5 b	7.2 a	4 b	6.4 b

[z]DAS = days after seeding.

[y]Percentage of the ACE stock solution. The stock solution was obtained by mixing 231 g of coffee grounds with 600 mL of water and stirring for 48 hours on a shaker plate.

[x]Means within a column with the same letters are not significantly different, according to least significant difference test (α=0.05).

[w]Means lower than the value in the previous day was due to seed mortality which may have been caused by over saturation of the seeds.

Table 5. Efficacy of spent coffee grounds (SCG) and pinebark (PB) used as mulch for control of *Trifolium repens* .

	Mulch		Number of emerged seedlings					
Treatment	Depth (inches)	Type	3 DAS[z]	6	10	14	28	FW[y]
1	0.0	-	2.5 a[x]	7.0 a	7.5 a	9.0 a	11 a	1 a
2	0.5	SCG	0.8 b	3.0 bc	3.8 bc	4.0 bc	3.8 c	0 c
3	1.0	SCG	0.0 b	0.5 d	0.8 de	1.5 de	1 d	0 c
4	1.5	SCG	0.0 b	0.0 d	0.0 e	0.0 e	0 d	0 c
5	3.0	SCG	0.0 b	0.0 d	0.0 e	0.0 e	0 d	0 c
6	0.5	PB	0.5 b	3.8 b	5.3 b	5.8 b	7.3 b	1 b
7	1.0	PB	0.0 b	1.3 cd	2.5 cd	2.5 cd	4 c	0 c
8	1.5	PB	0.0 b	0.0 d	0.0 e	0.3 e	0 d	0 c
9	3.0	PB	0.0 b	0.0 d	0.0 e	0.0 e	0 d	0 c

[z]DAS - days after seeding.

[y]FW - fresh weight in grams.

[x]Means within a column with the same letters are not significantly different, according to least significant difference test (α=0.05).

Postemergence Control of English Ivy (*Hedera Helix*)

Qian Yang, G. R. Wehtje and C. H. Gilliam
Auburn University, Dept. of Horticulture, Auburn, AL, 36849

qzy0002@auburn.edu

Index Words: English Ivy, Weed control, Herbicides

Significance to Industry: English ivy (*Hedera Helix*) is an evergreen vine growing on ground or climbing the trees which origins from European. This plant is almost disease free and good shade tolerant, and it is becoming an undesirable invasive weed in landscape in 18 States and the District of Columbia. This research indicates that English Ivy can be 78% postemergence controlled by Roundup applied at 3.0 lb ae/ A in August when the plant is actively growing. 2, 4-D was also effective, Vista and Milestone were much less effective than either Roundup or 2, 4-D.

Nature of Work: The best way to control English Ivy is to pull up the plant by hand (2), but the labor cost is too expensive to apply in landscape industry. A study done in 1985 on effects of timing and rate of Roundup application on selected woody ornamentals showed Roundup (glyphosate) applied at 3.0 kg ae/ha in March provided 100% control of English Ivy. June application provided 85% control at 3.0 kg ae/ha (3). Derr did 7 treatments on June 10, 1991, including Roundup at 2.2 and 4.5 kg ae/ha, Roundup at two rates with surfactant, 2, 4-D amine at 1.1 kg ae/ha, Banvel (Dicamba) at 0.6 kg ae/ha, and Garlon (Triclopyr) at 0.6 kg ae/ha. Result shows that Roundup applied at 4.5 kg ae/ha with surfactant provided almost 100% control. Roundup applied at 4.5 kg ae/ha provided 81% control of shoot fresh weight, but only 58% control at the 2.2 kg ae/ha rate. Addition of non-ionic surfactant did not further reduce growth. Shoot fresh weights were similar with Roundup (2.2 kg ae/ha), 2, 4-D, Banvel and Garlon. Roundup at 4.5 kg ae/ha rate with surfactant also controlled the weight of old growth (1). According to the Neal and Skroch (3), they obtained 85% control of English Ivy treated with Roundup in June at 3.0 kg ae/ha; similarly, Derr obtained 81% control with Roundup at 4.5 kg ae/A. Derr's study also introduced three other herbicide, 2, 4-D, Banvel and Garlon. They are all hormone mimic (growth regulator) herbicides. Newer herbicides, such as Milestone (aminopyralid) and Vista (fluroxypyr), have similar modes of action and possibly control English Ivy. The objective of our study was to evaluate new herbicides chemistry with Roundup and 2, 4-D for English Ivy control at varied rates.

Liners of English Ivy were potted on May 7, 2010, 2 plants in one trade gallon pot containing pine bark: sand (6: 1 volume). Herbicides were applied on August 23, 2010 to actively growing English Ivy. All pots were hand weeded before treatment. Applied herbicides included Roundup at 3.0, 2.0, 0.15, 0.95, 0.53, and 0.3 lb ae/acre; 2, 4-D amine at 2.0, 1.34, 1.0, 0.63, 0.35, and 0.2 lb ae/acre; Vista at 0.5, 0.34, 0.25, 0.16, 0.09, and 0.05 lb ea/acre; and Milestone at 0.25, 0.17, 0.11, 0.08, 0.045, and 0.025 lb ae/acre. Herbicides were applied as overhead foliar spray to English Ivy using a spray table delivering 30.1 GPA (Gallons per Acre) with Teejet 8002vs flat fan nozzles. The irrigation system was cut off until 24 hours after treatment. Plants were randomized and maintained outdoor under 40% shade cover and sprinkler irrigation system. The irrigation rate was 0.25 inch applied twice daily. Plant injury was rated at 7 (Aug 30), 15 (Sep 7), 30 (Sep 23), 45 (Oct 8) days after treatment. On a scale 1 to 10, 1 =no injury, 3 = distortion in terminal growth, 5 =burned growth and 10 =dead plant. Fresh shoot weights were recorded at 52 days (Oct 15) after treatment. Results were subjected to analysis variance with mean separation using the Least Significant Difference Test at p= 0.05.

Result and Discussion

English Ivy control with Roundup at 3.0 lb ae/A was the best of the four herbicides, and the results varied with applied rates (Table 1). Roundup at 3.0 lb ae/A provided 78% control at 53 days after treatment, while 2.0 lb ae/ A provided 71% control. English Ivy injury declined as the rate of Roundup application declined. Visual injury data followed a similar trend as the fresh weight. 2, 4-D provided approximately 60% control at rate≥ 1.34 lb ae/A. According to the LSD, there is no significant difference when 2, 4-D rate ranges from 0.35 to 2.00 lb ae/A. The visual injury also increased with increasing 2, 4-D rates. Vista provided poor control, and no effect for most rates application except 0.50 lb ae/A. Milestone also provided only poor control, and no significant different between all rates.

Overall, both Roundup and 2, 4-D provided fairly good postemergence control of actively growing English Ivy when applied in August. Conversely, Vista and Milestone were largely ineffective. The mean of each herbicide indicated 2, 4-D provided average best control in the four herbicides evaluated, while Roundup at 3.0 lb ae/A provided the highest individual treatment control.

Literature Cited

1. Derr, J. F. 1993 English ivy (Hedera Helix) response to postemergence herbicides. J. Environ. Hort. 11(2): 45-48.
2. Matthew, S. B. and Christopher, W. B. 2007. Effect of method of English Ivy removal and seed addition on regeneration of vegetation in Southeastern Piedmont Forest. Amer. Midland Natl. 158(1): 206-220.
3. Neal, J. C. and W.A. Skroch. 1985. Effects of timing and rate of glyphosate application on toxicity to selected woody ornamentals. J. Amer. Soc. Hort. Sci. 110: 860-864.

Table1 Performance of selected herbicide treatment on English Ivy control

Teatment		Plant Injury				F.W.[x]	Control[v]
Herbicide	Rate(ae/A[z])	7DAT[y]	15DAT[y]	30DAT[y]	45DAT[y]	(g)	(%)
Control	0	1.0[w]	1.0	1.0	1.0	68	0[u]
Roundup	0.30	2.2	2.6	1.8	1.0.	70	0
	0.53	2.2	2.8	1.6	1.0	60	11
	0.95	1.8	3.0	2.4	1.8	36	46
	1.50	2.4	3.4	3.2	3.6	33	51
	2.00	2.6	4.2	3.4	4.2	19	71
	3.00	3.0	4.6	4.4	5.6	15	78
Mean		2.4	3.4	2.8	2.9	39	42
2, 4-D	0.20	1.8	1.0	1.6	1.0	48	29
	0.35	2.2	2.0	1.8	1.0	44	35
	0.63	1.8	1.4	1.8	2.4	36	47
	1.00	2.2	2.2	2.0	3.2	36	46
	1.34	2.8	2.6	3.0	5.0	26	61
	2.00	2.2	2.4	3.0	5.2	28	59
Mean		2.2	1.9	2.2	3.0	36	46
Vista	0.05	2.0	1.6	1.2	1.0	68	0
	0.09	2.0	1.6	1.6	1.0	55	19
	0.16	1.8	1.6	1.0	1.0	62	9
	0.25	2.2	2.6	1.6	1.0	72	0
	0.34	2.0	2.2	1.4	1.0	45	33
	0.50	2.6	3.0	2.4	2.0	37	45
Mean		2.1	2.1	1.5	1.2	57	17
Milestone	0.025	2.0	1.4	1.2	1.8	41	40
	0.045	1.8	1.1	1.2	1.0	58	14
	0.08	2.0	1.0	1.4	1.6	50	26
	0.11	1.2	0.4	1.2	1.0	45	34
	0.17	2.0	0.7	1.2	1.2	49	28
	0.25	2.0	0.7	1.2	1.6	51	25
Mean		1.8	1.7	1.2	1.4	50	28
$LSD_{0.05}$[t]		0.9	0.9	0.7	1.0	19	28

[z]ae/A= pounds of active equivalents per acre
[y]DAT= days after treatment [x]F.W.= fresh weight in grams at 53 days after treatment.
[w]Means of five replications of visual rating, 1= no injury; 3= distortion in terminal growth 5= burned termi
[v]Control %= non-treated weight-treated weight)/ non-treated weight* 100.
[u]No control, fresh weight higher than, or equal to the control.
[t]Value for comparison between any two individual treatments within a column.