Perennial Cover Crop Evaluation for Enhanced Vineyard Floor Management

Final Research Report to the Virginia Wine Board and VDACS

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Introduction

Cover crops are an essential tool for a sustainable approach to vineyard floor management. Proper cover crop selection can help decrease herbicide use and mowing costs, as well as improve overall soil health. The objectives of this study are to 1.) Evaluate ease of establishment and persistence for cool season cover crops between vine rows, 2.) Evaluate weed suppression for each perennial cover crop, 3.) Determine crop suitability criteria such as: traffic, drought, and cold tolerance as well as maintenance requirements, 4.) Evaluate cover crop influence on overall soil health.

Materials and Methods

Two perennial cool season grass trails were established at Virginia Tech's Glade Road Research Center in Blacksburg, Virginia. First trial, a non-irrigated trial, was seeded on September 17, 2012. An irrigated trial was seeded on October 5, 2012. Plot size was 5 feet by 7 feet. One set of plots was not seeded and served as a control. Turf establishment and percent weed cover data was collected 2, 4, 8, and 12 weeks after treatment (WAT). Dominate weeds in the irrigated and non-irrigated plots were: henbit, bittercress, broadleaf dock, and buckhorn plantain. On November 20, 2012, Lontrel (clopyralid) was applied at 2/3 pt/A (0.5 fl oz/gal); and on December 4, 2012, Crossbow (2,4-D + triclopyr) was applied at 1.5 oz/gal for broadleaf weed control. These plots had not been mowed. No further irrigation was used during 2013 or 2014. Data collected on percent turf cover and weed cover was conducted on non-irrigated plots during this period. Turf and weed cover was monitored over a 94 week period.

A warm season trail was seeded on June 25, 2012. Dominant weed species in June, July and August were morningglory, galinsoga, yellow foxtail, carpetweed, Canada thistle, and dandelion. In September, corn speedwell and Canada thistle began to flourish. Galinsoga and carpetweed competed with all cover crops thus two applications of Lontrel at 1/3 pt/A was applied for broadleaf weed control. All warm season plots were mowed on August 15, 2012 at a 4 inch mowing height. This damaged the blue grama plots. Yellow foxtail invaded the plots during the summer and was the predominant weed following the Lontrel applications.

A traffic tolerant study was conducted during 2013 and 2014. A full-size truck was driven over plots once weekly at 3 mph, in the same direction. Percent turf was determined for each treatment in truck tire track area. No injury was found, so the frequency was doubled to twice a week in May 2013. The 2013 traffic treatments were stopped in October of 2013 and resumed in May 2014. Cover crops were allowed to regrow and reestablish during this time.

Two trials were established in Virginia Beach on September 21, 2012 and both were irrigated studies. Plot size was 5 feet by 7 feet. One set of plots was not seeded and served as a

control. Speedzone was applied at 2 pints per acre on 12/3/12 for broadleaf weed control to all plots except those containing microclover.

Select cover crops were chosen for a large-plot, on-farm research trial at Giles Mountain Vineyard and Winery, Staffordsville, VA. This trial was seeded on September 30, 2013. Plot size was 9 feet by 20 feet. The experimental dwarf tall fescue supplied by Allied Seed, LLC., was now available through Southern States as Eco Green Tall Fescue. Thus the two DTT 43 and 20 were combined into one product and used at this farm. Soil moisture and mowing requirement data was collected at this site. When cover crops reached 6 inches in height, they were mowed. Soil moisture data was collected using a 7 inch moisture probe. Three moisture readings were recorded per plot.

Results and Discussion

In the Blacksburg trials, the highest turf cover at 12 weeks after seeding (WAT) in the non-irrigated study occurred in the Rough and Ready mix, 'Applaud' perennial ryegrass, and 'Fawn' tall fescue (Table 1). The hard fescue and Kentucky bluegrass established slower than perennial ryegrass or tall fescue. By May, 2013, though, all had 90% cover or greater. Percent weed cover was inversely related to percent turf cover (Table 2). Weed cover was low in May 2013 in the seeded plots due to crop competition combined with the herbicide applications made the previous fall.

On April 12, 2013, traffic tolerance during the growing season was initiated at the Blacksburg study location. Despite the excessive rainfall, traffic injury was finally noted in July, 2013. Bareground plots and creeping red fescue showed the first signs of significant traffic injury. Sheeps fescue ('Bighorn GT') and Kentucky bluegrass displayed significant injury, but was not as severe as the creeping red fescue and bareground treatments (Table 3). All plots had significant regrowth during the fall and winter month. The study was repeated during 2014 with similar results: tall fescue had the greatest traffic tolerance, followed by 'Companion Grass', and the dwarf tall fescues.

Maximum growing height for the cover crops was recorded on November 18, 2013 in Blacksburg, VA (Table 4). These plots were mowed to remove seed heads in May 2013. Due to extensive rainfall in the early spring/summer of 2013, grass growth was excessive. Grasses that maintained the shortest growing height were dwarf tall fescue, 'Companion Grass', perennial rye, 'Rough and Ready' micro clover. Kentucky bluegrass and Bighorn GT were low growing, but due to poor weed suppression and drought tolerance, they would not be considered high quality cover crops for vine floor management. This study should be continued to capture the truth growth rate of these grasses under more 'typical' rainfall amounts.

In the irrigated trial, the highest turf cover early in the trial occurred in the Rough and Ready mix and in Applaud perennial ryegrass (Table 5). By May 2013, however, all cultivars contained 88% or greater cover. The herbicide applications eliminated the broadleaf weeds in these trials (Tables 2 and 6), which allowed for improved turf establishment.

During the 2014 growing season, May, June, July and August rainfall amounts were as follows: 2.68 in, 3.07 in, 1.92 in, and 5.95 in for Blacksburg. The dominate weed was white clover. Throughout the summer, Kentucky 31 tall fescue and creeping red fescue provided superior white clover control, followed by dwarf tall fescue. Due to low rainfall amounts, July data assessed drought tolerance in the cover crops. K31 tall fescue and dwarf tall fescues were the most drought

tolerant, maintaining 86% and 79% green turf for the month of July, respectively. Creeping red, 'Rough and Ready' microclover, and 'Companion Grass' became brown and only sustained 21%, 21% and 25% green turf, respectively.

In the warm-season trial, plots containing blue grama or annual ryegrass established quicker than the monoculture of zoysiagrass by 8 WAT (Table 7). By 12 WAT, all seeded plots contained about 70% turf cover. When evaluated in spring 2013, turf cover ranged from 60 to 75% depending on turf species. Weed cover ranged from 25 to 39% in the seeded plots in spring (Table 8). The warm season trial at Blacksburg was ended in 2014. Winter injury combined with mowing killed the blue grama treatment. Hairy galinsoga and crabgrass during the summer of 2013 dominated all plots. Another warm season trial was replanted, which included zoysia, two different cold-tolerant bermudagrasses, and blue grama. During the 2014 growing season, carpetweed, crabgrass, and hairy galinsoga dominated the warm season grass research trials and thus they were not considered viable cover crop choices for the Blacksburg area.

In the Virginia Beach trials, on December 11, 2012, 5 WAT, plots seeded with Kentucky bluegrass, hybrid bluegrass, or zoysiagrass plus Gotham hard fescue had less than 20% cover (Table 9). Other treatments resulted in 40 to 66% cover at this time. By June 2013, overall highest cover was with the tall fescue cultivars DTT43, DTT 20, Fawn, and Justice, ranging from 55 to 80% cover. Plots with perennial ryegrass, although having high cover in January, had unacceptable cover in June, probably due to heat and drought stress. The bluegrasses have not established successfully. Lowest weed cover in June was observed in plots of Fawn and Justice tall fescues, with the primary weeds being white clover and buckhorn plantain. Weed cover was inversely related to turf cover (Table 10). Speedzone was applied in December for winter weed control to all plots except those containing microclover.

Aurora Gold hard fescue did not establish in our trial (Table 11). Perhaps there was some problem with the seed batch. The other two hard fescues, Bighorn GT and Gotham, had approximately 45% cover by 16 WAT and 50 to 53% cover by June.

Creeping red fescue, 'Companion Grass' mix, dwarf tall fescue, 'Rough and Ready' microclover mix, and pasture grass were compared for mowing requirements and soil moisture during the 2014 growing season (Table 12). The pasture grass at this site was comprised of orchardgrass and tall fescue, with dominate weeds being musk thistle, broadleaf plantain, common yarrow, black nightshade, white clover, jimson weed, field bindweed, pigweeds, common blue violet, hairy bittercress, dandelion, and crabgrass. Pasture grass required 8 cuttings between May and September; followed by creeping red fescue at 6 cuttings, 'Companion Grass' and 'Rough and Ready' at 5 cuttings. Dwarf Tall fescue required the least number of cuttings at 4. Pasture grass plots had the least amount of soil moisture during July, August, and September. All other fescues were not significantly different. No significant traffic wear was noted for any cover crop at Giles Mountain Vineyard. Soil samples were taken for 2012, 2013 and 2014 growing seasons, however, no significant difference was determined for soil organic matter. This measure may change over a greater period of time.

Conclusions

All of the cool season grasses eventually attained excellent cover in Blacksburg, although certain ones, including perennial ryegrass and Fawn tall fescue, established faster. Although 'Companion Grass' mix, creeping red fescue, and 'Rough and Ready' microclover mix turned very

brown during the July drought in 2014, they regained their structure and performed well in August and September at Giles Mountain Vineyard. Dwarf tall fescue, 'Companion Grass' mix, creeping red fescue, and 'Rough and Ready' microclover mix displayed excellent weed control, provided sufficient low maintenance characteristics, and had fair to good drought and traffic tolerance. These cover crops also performed well at the large plot, on-farm experiment. These four cover crops are excellent choices for the cooler Blue Ridge region of Virginia.

The warm-season grasses have lower cover 6 months after seeding than the cool-season grasses, but the plots containing zoysia should increase over time as this grass spreads vegetatively by stolons and rhizomes. Only the tall fescue cultivars provided acceptable cover in Virginia Beach the following spring after seeding. Perennial ryegrass established quickly but cover decreased over time, probably due to heat and drought. The bluegrasses did not establish, probably due to weed competition resulting from slower cover crop germination. Different grasses will be needed for vineyards in the eastern part of Virginia compared to the western part.

Technology Transfer

On December 11, 2012 we hosted the quarterly New River Valley Grape Growers Meeting at the Glade Road Research Center. Mr. Charles Lytton, Giles County Extension, assisted us in conducting the meeting. We showed the three trials underway at the center, along with distributing a research summary sheet to the attendees. Attendance at this meeting included 27 local growers and vintners from Giles, Pulaski, Bedford, Roanoke and Montgomery counties. One June 9, 2013, the trials were discussed at the River Valley Grape Growers Meeting in Giles County. The importance of cover crops was discussed at the March 21, 2013 IPM in the Vineyard Workshop near Leesburg and at the April 9, 2013 IPM in the Vineyard Workshop near Fishersville.

The 2013 Blacksburg plots were labeled and a plot map is currently available to the public. Thus far, 20 people have visited the Blacksburg cover crop showcase vineyard. Interest is gaged by number of plot plans counted each month (see picture).

During April 2014, cool-season cover crop plots were showcased during the New River Valley Grape Growers Association Meeting. Four vineyards have adopted these grasses into their vine floor management plan. JVR Vineyard, located in Giles Co, has planted creeping red under trellis for weed and erosion control. Beliveau Estates, Montgomery County, VA, has planted dwarf tall fescue and creeping red mix under row as well as between row for weed suppression. Giles Mountain Vineyard and Winery, Staffordsville, VA, has planted 'Companion Grass' between row for decreased mowing costs on steep slopes. Finally, Farris Farms, Pulaski Co, VA, has planted creeping red fescue for weed control and decreased mowing cost on their 5 acre vineyard.

Table 1.Mean percent turf cover for perennial non-irrigated cool season cover crops seeded on September 17, 2012 in Blacksburg.

		% turf cover						
Treatment	**Seeding Rate (lb/1000 ft^2)**	**2 WAT**	**4 WAT**	**8 WAT**	**12 WAT**	**20 WAT**	**24 WAT**	**28 WAT**
'Bighorn GT' Sheep /Hard Fescue	2	0	5	18	22	68	90	90
'DTT-43' Dwarf Tall Fescue	2	0	16	38	45	66	93	92
'DTT-20' Dwarf Tall Fescue	2	0	13	29	44	71	95	93
'Rough and Ready' Microclover mix*	5	2	76	86	90	95	99	95
'Companion Grass ' Cover Crop Mixture**	1	2	28	53	65	86	99	92
'Applaud' Perennial Ryegrass	5	6	92	93	93	97	100	100
'Fawn' K31	2	4	83	90	91	97	98	95
'Midnight' Kentucky Bluegrass	1	0	4	8	15	49	92	90
'Silverlawn' Creeping Red Fescue	2	0	34	63	66	85	97	97
Unseeded (control)	0	0	0	0	0	0	0	0
LSD (p=0.05)		2	10	11	10	11	9	10

*34% Quatro Sheep Fescue, 30% Eureka II Hard Fescue, 30% PR8821 Perennial Ryegrass, 5 % Microclover

**80% PR8821 Perennial Ryegrass, 20% Creeping Red Fescue

Table 1. (Continued) Mean percent turf cover for perennial non-irrigated cool season cover crops seeded on September 17, 2012 in Blacksburg. On Aug 28, 2013 Acclaim (0.5oz/1000ft2) + QuickSilver (0.4 ml/1000ft2) was applied to all cover crops except the 'Rough and Ready' microclover mix.

		% turf cover					
Treatment	**Seeding Rate (lb/1000 ft^2)**	**34 WAT Jun 2013**	**38 WAT July 2013**	**42 WAT Aug 2013**	**46 WAT Sept 2013**	**50 WAT Oct 2013**	**54 WAT Nov 2013**
'Bighorn GT' Sheep /Hard Fescue	2	85	83	80	80	88	90
'DTT-43' Dwarf Tall Fescue	2	87	85	83	84	85	93
'DTT-20' Dwarf Tall Fescue	2	85	85	85	85	84	93
'Rough and Ready' Microclover mix*	5	99	95	90	91	95	97
'Companion Grass ' Cover Crop Mixture**	1	95	95	85	89	86	90
'Applaud' Perennial Ryegrass	5	90	92	83	85	85	87
'Fawn' K31	2	90	85	81	85	86	85
'Midnight' Kentucky Bluegrass	1	85	80	75	80	82	82
'Silverlawn' Creeping Red Fescue	2	99	95	96	99	99	98
Unseeded (control)	0	0	0	0	0	0	0
LSD (p=0.05)		8	9	7	9	9	9

*34% Quatro Sheep Fescue, 30% Eureka II Hard Fescue, 30% PR8821 Perennial Ryegrass, 5 % Microclover

**80% PR8821 Perennial Ryegrass, 20% Creeping Red Fescue

Table 1. (Continued) Mean percent turf cover for perennial non-irrigated cool season cover crops seeded on September 17, 2012 in Blacksburg. QuickSilver (0.4 ml/1000ft2) was applied to all cover cropss except the 'Rough and Ready' microclover mix on March 18 and May 12, 2014.

		% turf cover			
Treatment	**Seeding Rate (lb/1000 ft^2)**	**82 WAT May 2014**	**86 WAT June 2014**	**90 WAT July 2014**	**94 WAT August 2014**
'Bighorn GT' Sheep /Hard Fescue	2	47	45	38	65
'DTT-43' Dwarf Tall Fescue	2	92	89	79	93
'DTT-20' Dwarf Tall Fescue	2	85	85	78	92
'Rough and Ready' Microclover mix*	5	72	77	21	85
'Companion Grass ' Cover Crop Mixture**	1	51	36	25	81
'Applaud' Perennial Ryegrass	5	55	32	25	82
'Fawn' K31	2	98	99	86	99
'Midnight' Kentucky Bluegrass	1	12	17	19	25
'Silverlawn' Creeping Red Fescue	2	95	96	21	98
Unseeded (control)	0	0	0	0	0
LSD (p=0.05)		10	9	11	9

*34% Quatro Sheep Fescue, 30% Eureka II Hard Fescue, 30% PR8821 Perennial Ryegrass, 5 % Microclover

**80% PR8821 Perennial Ryegrass, 20% Creeping Red Fescue

Table 2. Mean percent weed cover for perennial non-irrigated cool season cover crops seeded on September 17, 2012 in Blacksburg. On Aug 28, 2013 Acclaim (0.5oz/1000ft2) + QuickSilver (0.4 ml/1000ft2) was applied to all covers except the 'Rough and Ready' microclover mix.

		% weed cover					
Treatment	**Seeding Rate (lb/1000 ft^2)**	**34 WAT Jun 2013**	**38 WAT July 2013**	**42 WAT Aug 2013**	**46 WAT Sept 2013**	**50 WAT Oct 2013**	**54 WAT Nov 2013**
'Bighorn GT' Sheep /Hard Fescue	2	15	17	20	20	12	10
'DTT-43' Dwarf Tall Fescue	2	13	15	17	16	15	7
'DTT-20' Dwarf Tall Fescue	2	15	15	15	15	16	7
'Rough and Ready' Microclover mix*	5	1	5	10	9	5	3
'Companion Grass ' Cover Crop Mixture**	1	5	5	15	11	14	10
'Applaud' Perennial Ryegrass	5	10	8	17	15	15	13
'Fawn' K31	2	10	15	19	15	14	15
'Midnight' Kentucky Bluegrass	1	15	20	25	20	18	18
'Silverlawn' Creeping Red Fescue	2	1	5	4	1	1	2
Unseeded (control)	0	100	100	100	100	100	100
LSD (p=0.05)		11	12	6	10	6	5

*34% Quatro Sheep Fescue, 30% Eureka II Hard Fescue, 30% PR8821 Perennial Ryegrass, 5 % Microclover

**80% PR8821 Perennial Ryegrass, 20% Creeping Red Fescue

Table 2. (Continued) Mean percent turf cover for perennial non-irrigated cool season cover crops seeded on September 17, 2012 in Blacksburg. QuickSilver (0.4 ml/1000ft2) was applied to all covers except the 'Rough and Ready' microclover mix on March 18 and May 12, 2014.

		% weed cover			
Treatment	**Seeding Rate (lb/1000 ft^2)**	**82 WAT May 2014**	**86 WAT June 2014**	**90 WAT July 2014**	**94 WAT August 2014**
'Bighorn GT' Sheep /Hard Fescue	2	53	55	43	31
'DTT-43' Dwarf Tall Fescue	2	8	11	14	5
'DTT-20' Dwarf Tall Fescue	2	15	15	15	5
'Rough and Ready' Microclover mix*	5	28	23	50	15
'Companion Grass ' Cover Crop Mixture**	1	49	64	50	15
'Applaud' Perennial Ryegrass	5	45	68	56	17
'Fawn' K31	2	2	1	1	<1
'Midnight' Kentucky Bluegrass	1	88	83	68	75
'Silverlawn' Creeping Red Fescue	2	5	4	5	2
Unseeded (control)	0	100	100	100	100
LSD (p=0.05)		12	7	14	5

*34% Quatro Sheep Fescue, 30% Eureka II Hard Fescue, 30% PR8821 Perennial Ryegrass, 5 % Microclover

**80% PR8821 Perennial Ryegrass, 20% Creeping Red Fescue

Table 3. Mean percent turf cover displayed after the start of traffic tolerance study initiated on April 12, 2013, for perennial cool-season cover crops seeded on September 17, 2012 in Blacksburg.

		% turf cover							
Treatment	**Seeding Rate (lb/1000 ft^2)**	**8 WAT Jun 2013**	**12 WAT July 2013**	**16 WAT Aug 2013**	**20 WAT Sept 2013**	**24 WAT Oct 2013**	**32 WAT June 2014**	**36 WAT July 2014**	**40 WAT Aug 2014**
'Bighorn GT' Sheep /Hard Fescue	2	100	100	79	48	55	80	54	51
'DTT-43' Dwarf Tall Fescue	2	100	100	100	93	93	99	89	85
'DTT-20' Dwarf Tall Fescue	2	100	100	100	99	99	99	87	81
'Rough and Ready' Microclover mix*	5	100	100	100	99	99	100	85	79
'Companion Grass ' Cover Crop Mixture**	1	100	100	100	99	99	99	90	88
'Applaud' Perennial Ryegrass	5	100	100	99	96	95	95	83	79
'Fawn' K31	2	100	100	100	88	91	100	99	95
'Midnight' Kentucky Bluegrass	1	100	100	94	74	79	17	42	20
'Silverlawn' Creeping Red Fescue	2	100	98	73	40	56	96	81	74
*Unseeded (control)	0	100	79	31	53	56	100	74	79
LSD (p=0.05)		NA	20	16	13	20	25	18	22

*Consisted of annual and perennial weeds

** Aug 28, 2013 Acclaim (0.5oz/1000ft2) + QuickSilver (0.4 ml/1000ft2) was applied to all covers except the 'Rough and Ready' microclover mix.

Table 4. Mean maximum turf height recorded on November 18, 2013 and August 12, 2014 for perennial Cool-season cover crops seeded on September 17, 2012 in Blacksburg.

	Maximum Turf Height (in)	
Treatment	**Actual (2013)**	**Actual (2014)****
'Bighorn GT' Sheep /Hard Fescue	20	18
'DTT-43' Dwarf Tall Fescue	31	18
'DTT-20' Dwarf Tall Fescue	23	17
'Rough and Ready' Microclover mix*	21	20
'Companion Grass ' Cover Crop Mixture**	25	21
'Applaud' Perennial Ryegrass	20	19
'Fawn' K31	55	47
'Midnight' Kentucky Bluegrass	16	18
'Silverlawn' Creeping Red Fescue	33	25
*Unseeded (control)	45	48

*consisted of annual and perennial weeds

**plots were mowed to 4 in on June 2, 2014

Table 5. Mean percent turf cover for perennial irrigated cool-season cover crops seeded on October 5, 2012 in Blacksburg.

		% turf cover					
Treatment	**Seeding Rate (lb/1000ft^2)**	**2 WAT**	**4 WAT**	**8 WAT**	**16 WAT**	**20 WAT**	**24 WAT**
'Bighorn GT' Sheep /Hard Fescue	2	0	4	6	67	91	89
'DTT-43' Dwarf Tall Fescue (Allied Seed Co.)	2	0	8	10	64	94	92
'DTT-20' Dwarf Tall Fescue (Allied Seed Co.)	2	0	9	10	68	96	93
'Rough and Ready' Microclover mix	5	6	40	43	88	97	92
'Companion Grass ' Cover Crop Mixture	1	2	18	24	82	99	95
'Applaud' Perennial Ryegrass	5	15	55	63	98	100	100
'Fawn' K31	2	8	33	35	97	95	90
'Midnight' Kentucky Bluegrass	1	0	2	4	45	90	88
'Silverlawn' Creeping Red Fescue	2	0	11	14	86	92	92
Unseeded (control)	0	0	0	0	0	0	0
LSD (p=0.04)		5	8	11	9	10	11

*On November 20, 2012, Lontrel was applied at 2/3 pt/A (15 ml/gal).

** On December 4, 2012, Crossbow was applied at 1.5 oz/gal.

Table 6. Mean percent weed cover for perennial irrigated cool-season cover crops seeded on October 5, 2012 in Blacksburg.

		% weed cover					
Treatment	**Seeding Rate (lb/1000ft^2)**	**2 WAT**	**4 WAT**	**8 WAT**	**16 WAT**	**20 WAT**	**24 WAT**
'Bighorn GT' Sheep /Hard Fescue	2	1	20	1	2	8	11
'DTT-43' Dwarf Tall Fescue (Allied Seed Co.)	2	1	15	1	3	6	8
'DTT-20' Dwarf Tall Fescue (Allied Seed Co.)	2	1	15	2	2	6	10
'Rough and Ready' Microclover mix	5	0	5	1	1	3	8
'Companion Grass ' Cover Crop Mixture	1	0	10	2	1	1	5
'Applaud' Perennial Ryegrass	5	1	5	0	0	0	0
'Fawn' K31	2	2	5	0	0	5	10
'Midnight' Kentucky Bluegrass	1	1	25	1	2	9	11
'Silverlawn' Creeping Red Fescue	2	2	15	1	2	8	8
Unseeded (control)	0	2	25	2	5	25	76
LSD (p=0.05)		1	8	1	3	4	5

*On November 20, 2012, Lontrel was applied at 2/3 pt/A (15 ml/gal).

** On December 4, 2012, Crossbow was applied at 1.5 oz/gal.

***Less weeds were present 8 WAT due to herbicide application

Table 7a. Mean percent turf cover for perennial warm season cover crops seeded on June 25, 2012 in Blacksburg.

		% turf cover				
Treatment	**Seeding Rate (lb/1000ft^2)**	**2 WAT**	**4 WAT**	**8 WAT**	**12 WAT**	**16 WAT**
'Bad River' blue grama	1	13	41	73	75	71
'Zenith' zoysia	2	1	0	35	63	63
'Zenith' zoysia + ryegrass*	2 + 1	14	58	69	69	66
'Bad River' blue grama + ryegrass*	1 +1	6	43	73	73	70
Unseeded (control)	0	0	0	0	0	0
LSD (p=0.05)		10	11	13	10	11

* annual ryegrass was from Green Seed Company, Knoxville, TN; Lot #L105-10-16G (variety: not stated)

Table 7b. Mean percent turf cover for perennial warm season cover crops seeded on June 25, 2012 in Blacksburg.

		% turf cover				
Treatment	**Seeding Rate (lb/1000ft^2)**	**20 WAT**	**28 WAT**	**32 WAT**	**36 WAT**	**40 WAT**
'Bad River' blue grama	1	23	71	72	70	71
'Zenith' zoysia	2	66	70	72	65	64
'Zenith' zoysia + ryegrass*	2 + 1	79	81	80	79	75
'Bad River' blue grama + ryegrass*	1 +1	44	41	45	40	60
Unseeded (control)	0	0	0	0	0	0
LSD (p=0.05)		14	11	12	15	11

Table 8a. Mean percent weed cover for perennial warm season cover crops seeded on June 25, 2012 in Blacksburg.

		% weed cover				
Treatment	**Seeding Rate (lb/1000ft^2)**	**2 WAT**	**4 WAT**	**8 WAT**	**12 WAT**	**16 WAT**
'Bad River' blue grama	1	9	41	14	20	26
'Zenith' zoysia	2	15	80	30	19	24
'Zenith' zoysia + ryegrass	2 + 1	12	22	19	9	21
'Bad River' blue grama + ryegrass	1 +1	12	37	18	31	31
Unseeded (control)	0	19	79	24	38	53
LSD (p=0.05)		6	17	15	11	17

*August 16, 2012 Lontrel was applied at 1/3 pt/A (7 ml/gal).
**August 30, 2012 Lontrel was applied at 1/3 pt/A (7 ml/gal).
***November 20, 2012, Lontrel was applied at 2/3 pt/A (15 ml/gal).

Table 8b. Mean percent weed cover for perennial warm season cover crops seeded on June 25, 2012 in Blacksburg.

		% weed cover				
Treatment	**Seeding Rate (lb/1000ft^2)**	**20 WAT**	**28 WAT**	**32 WAT**	**36 WAT**	**40 WAT**
'Bad River' blue grama	1	23	20	25	29	29
'Zenith' zoysia	2	20	15	28	32	36
'Zenith' zoysia + ryegrass	2 + 1	15	6	19	20	25
'Bad River' blue grama + ryegrass	1 +1	38	31	50	49	39
Unseeded (control)	0	63	34	60	80	95
LSD (p=0.05)		12	11	15	12	21

*August 16, 2012 Lontrel was applied at 1/3 pt/A (7 ml/gal).

**August 30, 2012 Lontrel was applied at 1/3 pt/A (7 ml/gal).
***November 20, 2012, Lontrel was applied at 2/3 pt/A (15 ml/gal).

Table 9. Turf cover in the first Virginia Beach trial.

		Percent turf cover				
	Seeding rate	10/5/12	10/24/12	12/3/12	1/10/13	6/28/13
Treatment	lb/1000 ft2	2 WAT	5 WAT	10 WAT	16 WAT	40 WAT
Companion grass	1	11	40	58	69	31
Rough and Ready	5	34	50	66	69	48
DTT 43	4	18	49	58	70	68
DTT 20	4	18	48	59	64	55
K 31 Fawn	4	14	50	65	60	80
Justice tall fescue	4	34	61	74	84	70
Mallard Ky bluegrass	1.5	3	5	15	28	16
Perennial ryegrass	4	55	66	74	84	21
Hybrid bluegrass	1.5	7	9	14	11	19
Zoysia + perennial ryegrass	1.5 2	33	53	68	83	20
Blue Grama	4	54	60	9	25	1
Zoysia + Gotham	1.5 2	9	16	23	45	58
No seed		0	2	5	0	3
LSD (P=.05)		11	10	11	18	15

Table 10a. Weed cover in the first Virginia Beach trial.

Treatment		Seeding rate		% weed cover 11/21/12 9 WAT			
				Henbit	Carolina geranium	Common chickweed	Speedwell
1	Companion grass	1	lb/1000 ft2	7	8	5	5
2	Rough and Ready	5	lb/1000 ft2	5	11	6	2
3	DTT 43	4	lb/1000 ft2	10	7	7	2
4	DTT 20	4	lb/1000 ft2	5	9	7	3
5	K 31 Fawn	4	lb/1000 ft2	5	10	5	3
6	Justice tall fescue	4	lb/1000 ft2	4	6	7	2
7	Mallard Ky bluegrass	1.5	lb/1000 ft2	11	16	21	3
8	Perennial ryegrass	4	lb/1000 ft2	3	5	5	1
9	Hybrid bluegrass	1.5	lb/1000 ft2	8	16	7	2
10	Zoysia +	1.5	lb/1000 ft2	4	5	9	1
10	perennial ryegrass	2	lb/1000 ft2				
11	Blue Grama	4	lb/1000 ft2	18	9	10	5
12	Zoysia	1.5	lb/1000 ft2	9	24	7	3
12	Gotham	2	lb/1000 ft2				
13	No seed			18	5	12	7
LSD (P=.05)				7.4	5.9	11.0	4.0

Table 10b. Weed cover in the first Virginia Beach trial.

Treatment		Seeding rate		% cover 11/21/12 9 WAT			
				Shepherd's purse	Buttercup	Vetch	Buckhorn plantain
1	Companion grass	1	lb/1000 ft2	7	13	1	3
2	Rough and Ready	5	lb/1000 ft2	5	4	3	3
3	DTT 43	4	lb/1000 ft2	2	4	6	2
4	DTT 20	4	lb/1000 ft2	14	10	5	3
5	K 31 Fawn	4	lb/1000 ft2	8	11	6	2
6	Justice tall fescue	4	lb/1000 ft2	8	5	7	3
7	Mallard Ky bluegrass	1.5	lb/1000 ft2	6	8	10	4
8	Perennial ryegrass	4	lb/1000 ft2	2	4	10	3
9	Hybrid bluegrass	1.5	lb/1000 ft2	13	12	6	13
10	Zoysia +	1.5	lb/1000 ft2	1	4	9	3
10	perennial ryegrass	2	lb/1000 ft2				
11	Blue Grama	4	lb/1000 ft2	2	9	8	3
12	Zoysia	1.5	lb/1000 ft2	6	14	2	15
12	Gotham	2	lb/1000 ft2				
13	No seed			8	12	10	5
LSD (P=.05)				11.3	6.2	8.0	12.2

Table 10c. Weed cover in the first Virginia Beach trial.

Treatment	Seeding rate lb/1000 ft2	Weed cover 11/21/12 9 WAT	Weed cover 6/28/13 40 WAT	Clover cover 7/3/13 41 WAT	Buckhorn plantain cover 7/3/13 41 WAT
Companion grass	1	49	45	12	33
Rough and Ready	5	38	36	14	28
DTT 43	4	40	20	12	11
DTT 20	4	55	30	14	21
K 31 Fawn	4	50	8	5	14
Justice tall fescue	4	41	16	9	16
Mallard Ky bluegrass	1.5	77	63	14	29
Perennial ryegrass	4	33	44	14	33
Hybrid bluegrass	1.5	76	65	9	46
Zoysia + perennial ryegrass	1.5 2	36	50	13	35
Blue Grama	4	63	70	20	26
Zoysia + Gotham	1.5 2	79	38	13	35
No seed		77	73	6	39
LSD (P=.05)		18	16	13	18

Table 11. Turf and weed cover in the second Virginia Beach trial.

Treatment	Seeding rate lb/ 1000 ft2	Percent turf cover					% weed cover	
		10/5/12	10/24/12	11/28/12	1/10/13	6/28/13	11/16/12	6/28/13
		2 WAT	5 WAT	10 WAT	16 WAT	40 WAT	8 WAT	40 WAT
Bighorn GT	2	7	19	34	43	50	89	45
Aurora Gold	2	1	2	15	0	1	100	80
Gotham	2	11	23	34	46	53	99	43
LSD (P=0.05)		4	9	7	8	14	18	16

Table 12. Soil moisture content and maintenance collected at Giles Mountain Vineyard, Staffordsville, VA for select cover crops seeded on September 30, 2013.

Treatment	**Seeding Rate** (lb/1000 ft^2)	**% soil moisture**			**Total No. Grass Mowings**
		36 WAT July 2014	**40 WAT Aug 2014**	**44 WAT Sept 2014**	
Dwarf Tall Fescue	2	3.3	15.1	13.5	4
'Rough and Ready' Microclover mix*	5	3.8	15.6	12.9	5
'Companion Grass ' Cover Crop Mixture**	1	3.6	14.2	13.1	5
'Silverlawn' Creeping Red Fescue	2	4.9	15.0	12.3	6
Pasture Grass (control)	0	2.1	13.5	10.2	8
LSD (p=0.05)		1.1	1.5	1.9	NA

*Grass height was maintained at 6 in growing height May to September.