Project I: Efficacy of sulfonylurea herbicides for improved transition on bermudagrass fairways

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Cooperator: Kevin Kienast, Morgan Run Golf Resort

Sponsor: Chris Olsen, Bayer; Dean Mosdell, Syngenta

Summary: A replicated small plot study was conducted on ryegrass overseeded bermudagrass fairways to evaluate the ability of several herbicide products to remove overseeded perennial ryegrass and thus improve the quality of the underlying bermudagrass base. Based on the results, the following conclusions were drawn:

- All treatments produced significantly accelerated increases in bermudagrass cover vs. the untreated check. The greatest increases were seen with Revolver (0.2 oz/1000 sq ft), applied early in the season (5/7/03).
- All treatments produced relatively rapid (within 1-3 weeks) death of perennial ryegrass and *Poa annua.*
- All treatments produced some yellowing of turf or in some cases some bare spots, due to death of perennial ryegrass. The period of significant yellowing and/or bare patches lasted from 5 weeks to greater than 9 weeks, depending on the treatment tested. In this coastal environment with its very gradual spring/summer warming trend, significant yellowing of 5 weeks or more should be expected with any of the products tested. If the spring is unseasonably cool (prolonged periods with average temperatures below 65F), this period can be significantly extended.
- No damage to hybrid or common bermudagrass was observed. However, due to its inherently slower growth rate, areas with common bermudagrass were slower to recover from herbicide applications than areas with hybrid bermudagrass.
- Treatments made later in the year, when average air temperatures were greater than 65F, produced less severe yellowing of turf than applications made earlier in the year. Based on the 30-year normal data for Morgan Run Golf Club (Table 1), this threshold temperature would typically be reached by mid-June.
- The Hhalf rate (0.2 oz/1000 sq ft) of Revolver produced a less severe and a shorter duration of turf yellowing than the full rate, without any decrease in herbicidal activity. While the lowered rate may result in decreased herbicidal activity for hard-to-kill weeds, the idea of reduced rates should be considered more seriously in geographic regions (such as coastal California) where the prolonged period of yellowing turf produced by sulfonylureas used at the full labeled rate may be unacceptable. It may be that a slight loss in herbicidal activity would be a small price to pay if a significant reduction in turf yellowing accompanied it.
- Overall, the best combination of results (increased bermudagrass stand with the smallest duration and least severe yellowing of turf) was produced when applications were timed at bermudagrass cover greater than 50%, when average air temperatures were 65F or higher, and/or when average soil temperatures (6" depth) were 70F or higher. The data suggests the possibility that lowered product rates may help to reduce the period of turf yellowing while still providing acceptable ryegrass control (see above). These conclusions apply to the Southern California coastal climate under which this trial was conducted, and may not apply in other locations with different weather patterns.
- Kerb is the current commercial standard for ryegrass removal. It produced a more gradual transition to bermudagrass than either Revolver or Monument. However, Kerb has the undesirable features of inconsistent performance (perhaps due to its inactivation in high organic matter [>4%] soils) and significant soil mobility.
- Variability on the golf course can produce varying results with sulfonylurea herbicides. In areas where bermudagrass cover is low and the percentage of cool season turf is high (greater than 50%), such as shaded, cool or wet areas, rye removal products are probably not a viable commercial option, unless long periods (8 weeks or more) of yellowing turf can be tolerated. Likewise, during cool summers, bermudagrass cover may never reach the critical level to trigger herbicide applications. Finally, the presence of common bermudagrass, which is an inherently slower growing turf than hybrid bermudagrass, will also result in a longer time period after application during which bare areas will persist.
- For all of the reasons above, the benefits of sulfonylurea herbicides for rye removal on overseeded fairways in coastal California remain mixed, since the risk of yellowing fairways for 5 weeks or more may outweigh the benefits of improved bermudagrass stands. The decision to use these products will depend on the golf course and the situation:

- For golf courses that do not overseed, the benefits of sulfonylurea herbicides for control of rye, poa and other weeds are obvious and non-controversial.
- For golf courses that are committed to improved bermudagrass stands and are willing to accept yellowing turf during June and July, these products have a definite benefit, especially if a multi-year commitment (see Project II below) to this process is made.
- For golf courses that are looking for a quick and painless way to remove ryegrass from overseeded fairways, the benefits of sulfonylurea herbicides are less clear. The rye can definitely be removed quickly by all of the products tested, but some pain will always be involved in the form of extended periods of yellowing turf.

Materials and Methods

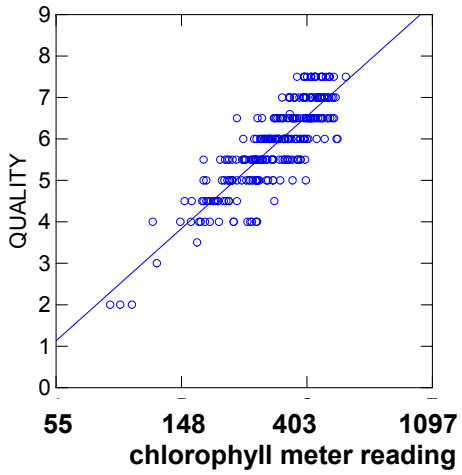
Treatments: Treatments tested are listed in Table 2 below.

Experimental design and application: The trial was conducted at Morgan Run Golf Resort, Rancho Santa Fe, CA (Kevin Kienast, superintendent) on a fairway (mixture of common and hybrid bermudagrass) that was overseeded with perennial ryegrass. All plots were in full sun. Plots measured 5 feet by 10 feet and treatments were replicated three times, in a randomized design. Applications were made with a CO_2 backpack sprayer equipped with 8004 VS flat fan nozzles and delivering 0.98 gallons of water per 1000 square feet, with 30 psi at the boom. Calibration of each nozzle was confirmed prior to application to be within 5% of the desired nozzle flow rate. Boom height was 17 inches above the ground. The spray swath was 5 feet. Speed was 3 mph. Spray bottles were agitated by shaking 20 times prior to charging with compressed CO_2. Spray lines were purged with CO_2 and then water prior to changing treatments.

A single application of each product was made to the plots on either 5/7/03 (targeted as an "early" application when bermudagrass cover was <50%) or on 6/4/03 (targeted as a "late" application when bermudagrass cover was closer to 50%).

Evaluations: Overall turf quality and percentage bermudagrass cover were measured 0, 1, 3, 4, 6, 8 (both evaluations) and 14 weeks (Bermuda cover only) after the first treatment. Quality was rated using a Spectrum Field Scout chlorophyll meter (Spectrum Technology; Field Scout CM1000) that measures ambient and reflected 700 nm and 840 nm light to calculate a relative chlorophyll index. After extensive use of the meter in variety trials and fertilizer trials, it has proven to be an objective and highly sensitive method for rating turf quality (Figure 1). Three readings per plot were taken on each evaluation date and averaged. Percentage bermudagrass cover was evaluated visually.

Figure 1. Correlation between visual turf quality data and Spectrum chlorophyll meter readings, generated in a separate turf variety trial conducted at Fairbanks Ranch Country Club, based on 262 paired observations (r^2 = 0.73 ($p<0.001$)



Data analysis: Data was subjected to analysis of variance, and treatment means were separated using Fisher's LSD, where $P<0.05$. For the purposes of analysis, percentage bermudagrass cover data was transformed using the arcsine transformation (= arcsine(square root (proportion))).

Results

Weather: The closest CIMIS station to Morgan Run Golf Club was station 49, located in Oceanside, CA. Average air temperatures and average soil temperatures for April – August of 2002 and 2003 are presented in Figures 2 and 3.

Turf quality:

- Comparison to untreated check: None of the treatments had significantly higher turf quality than the non-treated check on any of the rating dates, and in many cases (particularly within the first few weeks of application for the "early" application timing) the treatments produced significantly lower quality turf than the check. Lower quality was the result of the yellowing and death of perennial ryegrass – an effect that lasted as little as 5 weeks (0.2 oz Revolver, applied 5/7) and up to greater than 9 weeks (Revolver applied 6/4/03).
- Product comparison and application timing: When products applied at the "early" application timing were compared, Revolver (0.2 oz)

produced significantly less damage than either Revolver at 0.4 oz, Kerb or Monument. However, at the "late" application timing, no statistically significant differences among treatments were observed. There was a trend, however, to suggest that Revolver caused a greater decline in turf quality than either Kerb or Monument at the late application timing. In general, the late application timing produced less serious declines in turf quality than the early application timing, regardless of the product tested.

- Effect of Revolver rates: At the "early" application timing, Revolver at 0.4 oz/1000 sq ft caused significantly more turf damage than the 0.2 oz rate. However, at the "late" application timing, both rates of the product performed similarly.

Bermuda Cover:

- Percent bermuda cover on untreated plots at the time of application was 53 – 58% on the "early" application date (May 7), and 43 – 65% on the "late" application date (June 4, 2003). The fact that bermudagrass cover was higher than expected in early May was at least partly due to the fact that the test area was in full sun (as opposed to the 2002 test area, a portion of which was in partial shade). The fact that bermudagrass cover may have slightly decreased in the time period from May to June was probably due to the drop in average air temperatures during the last two weeks of May, 2003 (see Figure 2). This drop in temperature caused a resurgence of ryegrass growth and a concomitant decrease in bermudagrass cover.

  The lack of increase in the bermudagrass stand between May and June somewhat compromised our ability to evaluate "early" vs. "late" application timings. Since the bermudagrass stand was essentially the same on both application dates, the results reveal less about application timing than they might have if the season had progressed "normally", with consistently rising air temperatures between May and June. Nevertheless, the "late" application timings did produce significantly different results in terms of turf quality and bermudagrass cover (see below). This is likely due to the fact that air and soil temperatures (and therefore bermudagrass cover, see Figures 2 and 3) continued to gradually increase in June, July and August, giving the "late application" treatments a more conducive environment for recovery from rye removal products.

- Product comparison: When products applied at the "early" application timing were compared, Revolver (0.2 oz) performed significantly better than any other product. Revolver (0.4 oz) and Monument were in the middle tier of performers, while Kerb had the least effect on bermudagrass cover. When products were applied at the "late" application timing, product performance rankings were a bit different, with Monument and Kerb performing significantly better than either rate of Revolver.

- Timing of application comparison: For Revolver, an early application timing produced significantly better results than the late application timing. For Monument, application timing had little effect on performance, and for Kerb, a late application timing was significantly better than an early application timing.

- Effect of Revolver rates: rates of 0.2 oz and 0.4 oz/1000 sq ft were compared at both application timings. In neither case was a rate response observed for percent bermudagrass cover, and on one date, the performance of the lower rate was significantly better than that of the higher rate. On the basis of these results, application with 0.2 oz/1000 was as efficacious as treatment with the 0.4 oz/1000 sq ft rate. The reasons for the improved performance of a lower rate of Revolver are not clear, unless the more gradual effect of rye removal has some benefit.

Application timing

On the basis of two years of testing sulfonylurea products in this location, and on the weather records of the nearest CIMIS station, some general conclusions can be drawn:

- Turf quality decreases were most severe when average air temperatures were below 65F and average soil temperatures were below 70F at the time of application.

- The extent of increases in bermudagrass cover were less the result of application timing, and more a result of the interaction between the product used and application timing. Thus, Revolver was more effective at increasing bermudagrass cover when applied "early" (average air temperatures 60F and average soil temperature 65F), while Kerb was more effective when applied "late".

Figure 2. Average air temperatures for April 15 – August 13, 2002 and 2003. CIMIS Station 49, Oceanside, CA. Application dates for the 2002 and 2003 trials are indicated by arrows.

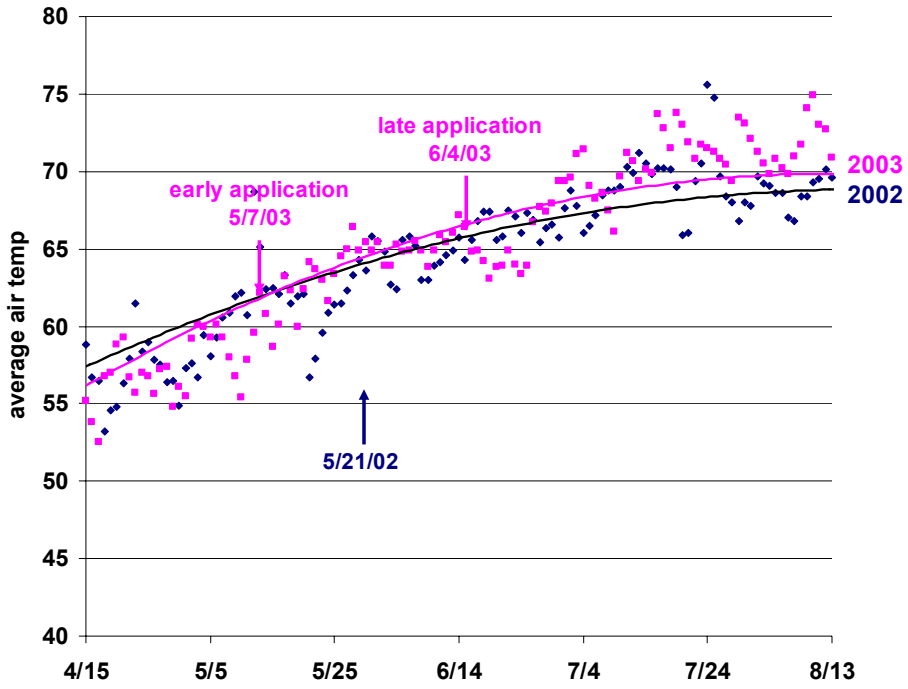


Figure 3. Average soil temperatures for April 15 – August 13, 2002 and 2003. CIMIS Station 49, Oceanside, CA. Application dates for the 2002 and 2003 trials are indicated by arrows.

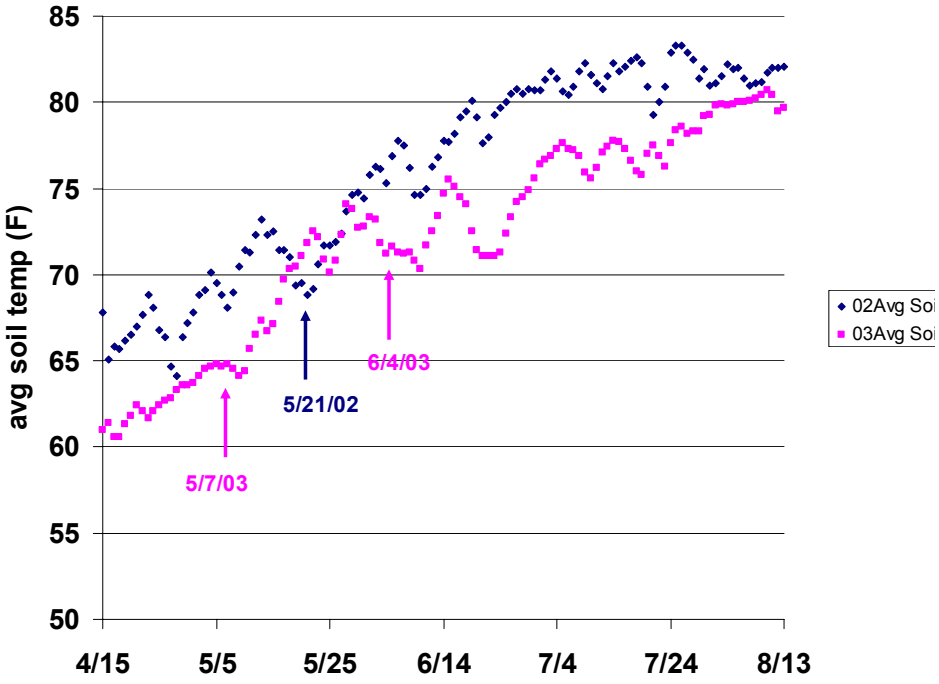


Figure 4. Percent bermudagrass cover for Revolver, Kerb and Monument applied at the “early” application date of 5/7/03.

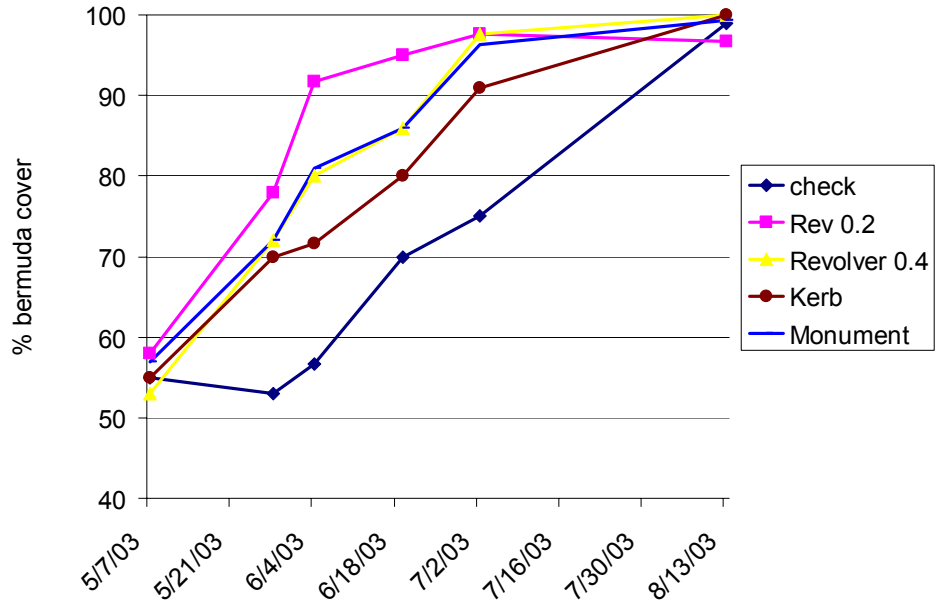


Figure 5. Percent bermudagrass cover for Revolver, Kerb and Monument applied at the “late” application date of 6/4/03.

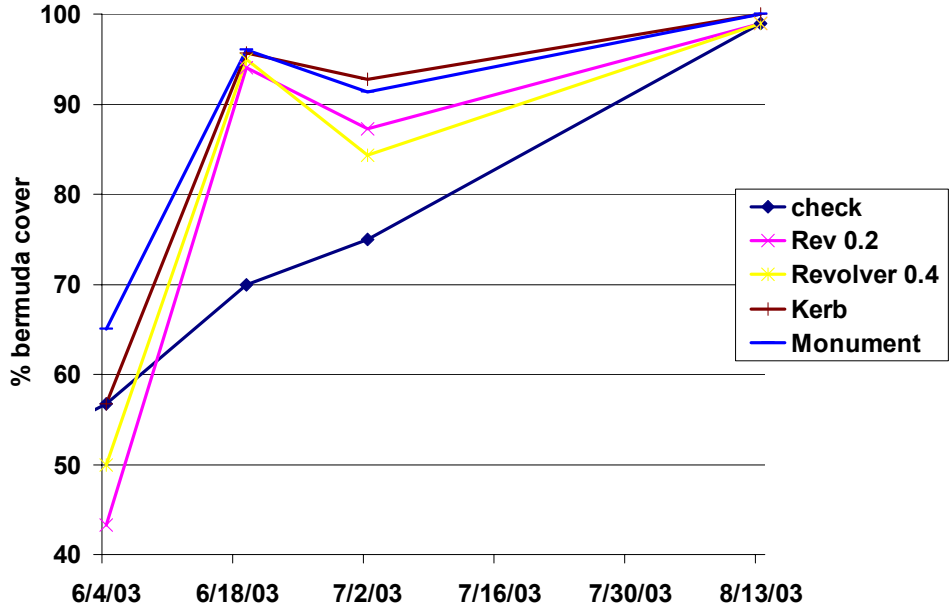


Figure 6. Percent turf quality ratings for Revolver, Kerb and Monument applied at the “early” application date of 5/7/03.

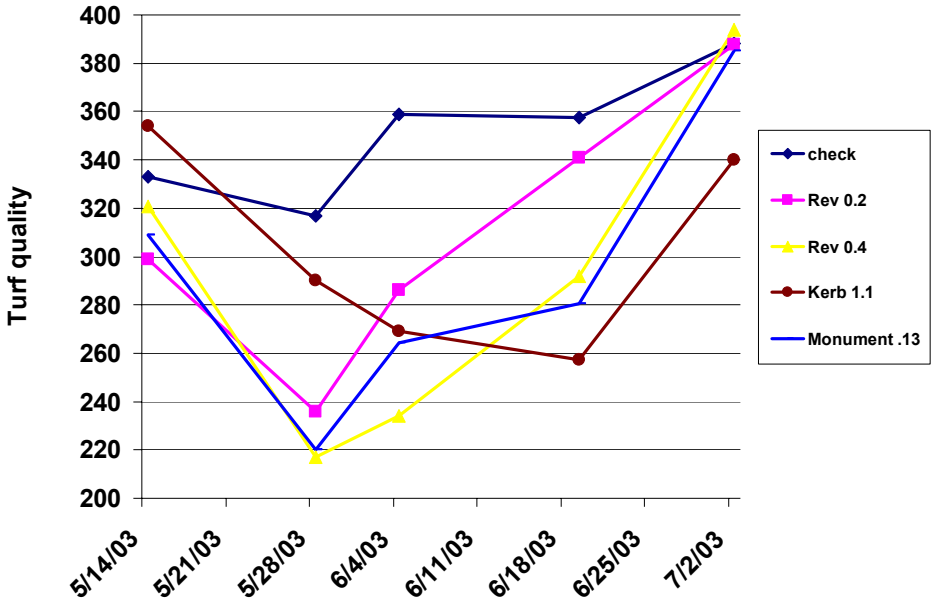
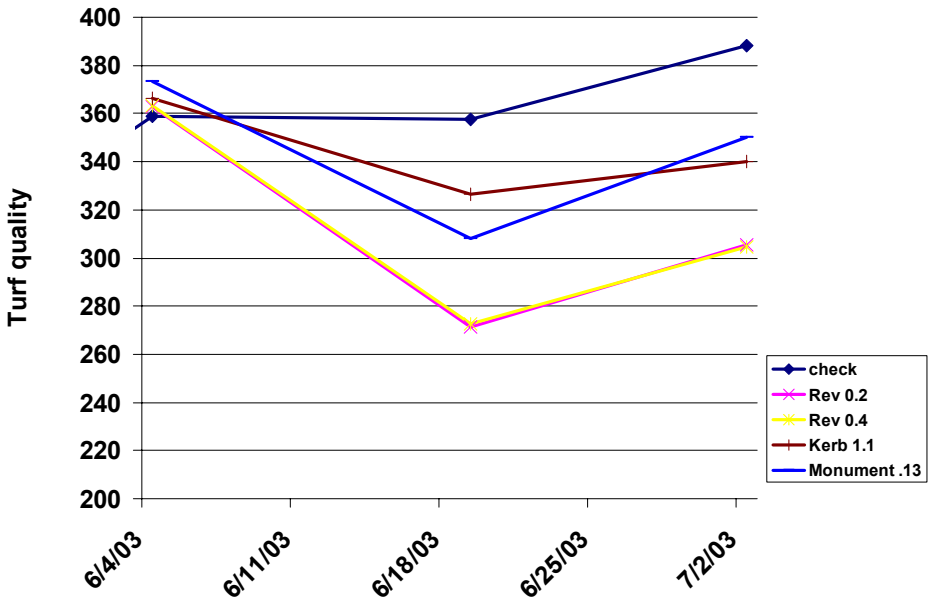


Figure 7. Turf quality ratings for Revolver, Kerb and Monument applied at the “late” application date of 6/4/03.



Figures 8 – 18: early application timing (5/7/03).

Figure 8. 5/14/03 (1WAT). No treatment (1) vs. Revolver 0.2 oz/1000 sq ft (2). Visible reductions in ryegrass were evident as early as 1 week after treatment.

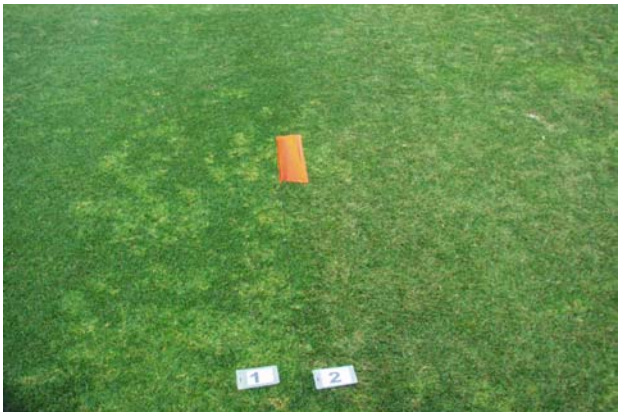


Figure 9. 5/14/03 (1 WAT). No treatment (1) vs. Monument 0.0046 oz/1000 sq ft (8). Ryegrass kill was not quite as rapid as that seen for Revolver (Figure 8).

Figure 10. 5/28/03 (3 WAT). No treatment (1) vs. Revolver 0.2 oz/1000 sq ft (2). Significant increases in bermudagrass cover were observed in the Revolver plots.

Figure 11. 5/28/03 (3 WAT). No treatment (1) vs. Monument 0.0046 oz/1000 sq ft (8). Significant increases in bermudagrass cover were observed in the Monument plots. However, the reduction in a previously heavy ryegrass population caused the plots to look thin and discolored.

Figure 12. 5/28/03 (3 WAT). Overall shot showing the variation in turf discoloration resulting from SU applications. Note that in areas of predominantly hybrid bermudagrass (yellow arrow), the turf is filled in substantially, while in areas of predominantly common bermudagrass which is slower growing (white arrow), there are still significant bare patches.

Figure 13. 5/28/03 (3 WAT). Close up of predominantly common bermudagrass area of the trial. In these areas, where the common bermudagrass was slow to fill in, applications of Revolver at 0.4 oz (3) or Monument 0.0046 oz (8) resulted in significant bare patches. A non-treated area is shown in the top of the photo.

Figure 14. 6/4/03 (4 WAT). No treatment (1) vs. Revolver (0.2 oz/1000 sq ft.)

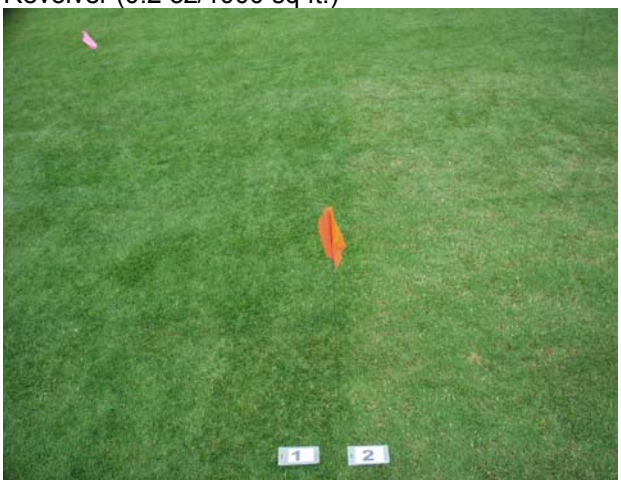


Figure 15. 6/4/03 (3 WAT). No treatment (1) vs. Kerb 1.1 oz/1000 sq ft (6). Note the much more subtle/gradual effects of Kerb on rye removal and bermudagrass increase rates.

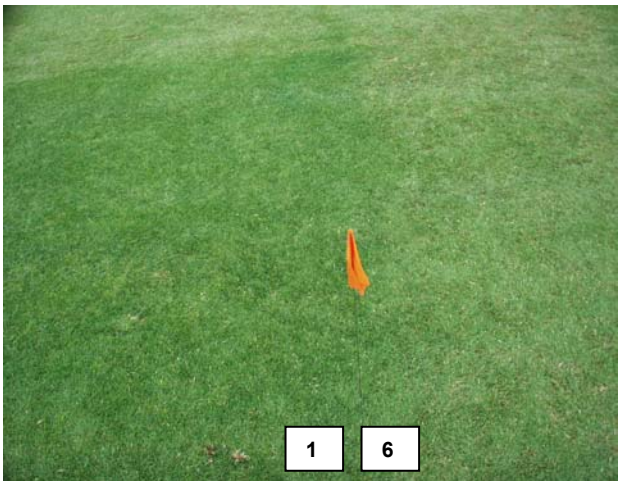
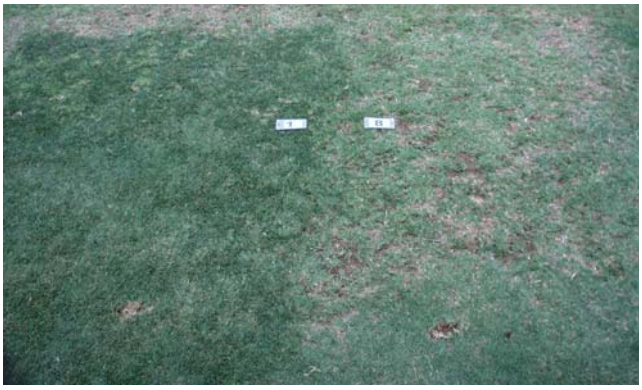


Figure 16. 6/4/03 (4 WAT). Common bermudagrass has begun to slowly recolonize the areas shown in Figure 13. Treatment 3 = Revolver 0.4 oz/1000 sq ft. Treatment 8 = Monument 0.0046 oz/1000 sq ft.

Figure 17. 6/18/03 (6 WAT). No treatment (1) vs. Revolver (0.2 oz/1000 sq ft.) (2). Product was applied 5/7/03.

Figure 18. 7/2/03. Untreated check (trt 1) vs. Revolver, 0.2 oz/1000 (trt 2), 8 WAT.

Figure 19. 6/18/03. In areas of predominantly common bermudagrass, early applications of Monument (trt 8; right hand plot) still had significant areas of bare soil, 6 WAT. Trt 1 (plot to left) is the untreated check.



Figures 20 – 29. Comparison of early vs. late application timing.

Figure 20. 6/18/03. Revolver (0.4 oz) applied 5/7/03 (trt 3, 6 WAT) vs. Revolver (0.2 oz) applied 6/4/03 (trt 4, 2 WAT). There were no significant differences between the treatments on this date, indicating that the later application timing is a feasible option.

Figure 21. 6/18/03 Revolver (0.4 oz) applied 6/4/03 (trt 5; 2 WAT) vs. Kerb (1.1 oz) applied 5/7/03 (6 WAT). Note that there is still rye remaining in the Kerb plot, 6 WAT.

Figure 22. 6/18/03. Kerb applied early, on 5/7/03 (trt 6) vs. Kerb applied late, on 6/4/03 (7). The early treatment produced somewhat more yellowing than the late application date, but this is not evident in this replicate of the trial.

Figure 23. 6/18/03. Monument applied early, on 5/7/03 (trt8, 6 WAT) vs. Monument applied late, on 6/4/03 (trt 9, 2 WAT). Rye control was roughly the same with both application timings, but the late treatment produced less yellowing and bare areas.

Figure 24. 6/18/03**.** Monument (trt 9) applied on 6/4/03 (late application timing) vs. the untreated check (treatment 1).

Figure 25. 7/2/03. Revolver 0.4 oz, applied on 5/7/03 (trt 3; 8 WAT) vs. Revolver, 0.2 oz, applied on 6/4/03 (trt 4, 4 WAT). These treatments performed roughly the same.

Figure 26. 7/2/03. Revolver at 0.4 oz/1000 sq ft (trt 5) was applied 6/4/03. Kerb at 1.1 oz/1000 sq ft (trt 6) was applied on 5/7/03.

Figure 27. 7/2/03. Kerb applied on 6/4/02 (trt. 7) vs. the untreated check (trt 1). 4 WAT.

Figure 28. 7/2/03. Monument applied on 5/7/03 (trt8, 8 WAT) vs. Monument applied on 6/4/03 (trt 9, 4WAT). These treatments performed roughly the same.

Figure 29. 7/2/03. Monument applied on 6/4/03 (trt9) was performing well 4 WAT, although some bare spots persisted in areas of common bermudagrass.

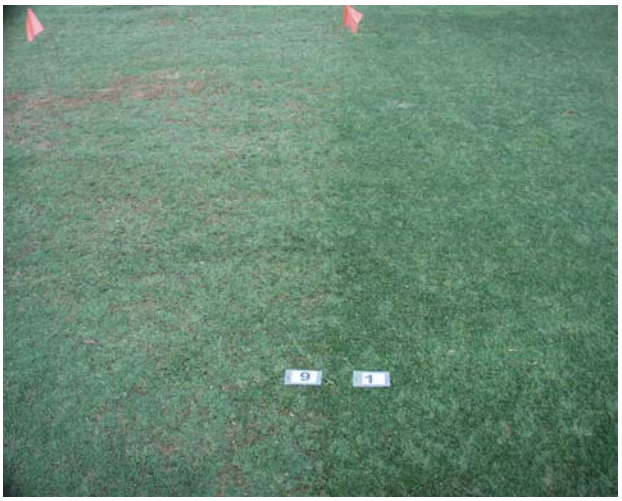


Table 1. Thirty-year normal data for Morgan Run Golf Club.

Climate Appraisal

Kevin Kienast — Morgan Run Resort & Club

City: Rancho Sante Fe State: CA Elevation (ft): 10 Elevation (m): 3

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal Average Temperature (F)	55	55	56	58	61	64	68	69	67	64	58	55
Normal Average Temperature (C)	12.6	12.9	13.5	14.6	16.2	17.9	19.8	20.3	19.7	17.7	14.7	12.7
Normal Precipitation (in)	2.4	2.2	2.1	0.9	0.2	0.1	0.0	0.1	0.3	0.4	0.9	1.3
Normal Precipitation (cm)	6.1	5.7	5.4	2.3	0.6	0.2	0.1	0.3	0.7	1.1	2.3	3.4
Cool season GP	41.3	44.1	49.8	61.9	79.4	93.0	99.9	99.8	99.8	91.6	63.1	42.4
Warm season GP	0	0	1	1	3	6	12	15	12	5	1	0
Cool season lb N/1000 sq ft	0.41	0.44	0.49	0.61	0.79	0.93	0.99	0.99	0.99	0.91	0.63	0.42
Cool season g N/100 sq m	200	215	239	298	386	454	484	484	484	445	308	205
Warm season lb N/1000 sq ft	0.00	0.00	0.00	0.01	0.02	0.05	0.12	0.15	0.11	0.05	0.01	0.00
Warm season g N/100 sq m	0	0	0	5	10	24	59	73	54	24	5	0

Table 2. Percent bermudagrass cover. Treatments significantly better than the untreated check on each date are highlighted in yellow. The only treatment to perform better than the check on three dates was treatment 2: Revolver 0.2 oz, applied on 5/7/03.

Trt #	Product	Rate/1000 sq ft	Application date	5/7	5/28	6/4	6/18	7/2	8/13
1	check	--	--	55 a	53 a	56.7 cd	70 b	75 b	99 a
2	Revolver 22.5 SC	0.2 oz	5/7/03: early	58 a	78 a	91.7 a	95 a	97.7 a	96.7 a
3	Revolver 22.5 SC	0.4 oz	5/7/03: early	53 a	72 a	80 ab	86 ab	97.7 a	100 a
4	Revolver 22.5 SC	0.2 oz	6/4/03: late			43.3 d	94 a	87.3 ab	99 a
5	Revolver 22.5 SC	0.4 oz	6/4/03: late			50 cd	95 a	84.3 ab	99 a
6	Kerb WSP	1.1 oz	5/7/03: early	55 a	70 a	71.7 abc	80.1 ab	91 a	100 a
7	Kerb WSP	1.1 oz	6/4/03: late			56.7 cd	95.7 a	92.7 a	100 a
8	Monument 75 WG	0.0046 oz	5/7/03: early	57 a	72 a	81 ab	86 ab	96.3 a	99.3 a
9	Monument75 WG	0.0046 oz	6/4/03: late			65 bcd	96 a	91.3 a	100 a

Table 3. Turfgrass quality. Treatments significantly worse than the untreated check on each edate are highlighted in red. None of the treatments tested was significantly better than the untreated check on any of the dates evaluated. Treatments that resulted in the highest damage levels to turf were treatments 3 (Revolver at 0.4 oz, 5/7 application date) and 8 (Monument at 0.0046 oz, 5/7/ application date)

Trt #	Product	Rate/1000 sq ft	Application date	5/14	5/28	6/4	6/18	7/2
1	check	--	--	333 a	317 a	359 ab	357.7 a	388 a
2	Revolver 22.5 SC	0.2 oz	5/7/03: early	299 a	236 ab	286 bc	341.0 a	387.7 a
3	Revolver 22.5 SC	0.4 oz	5/7/03: early	321 a	217 b	234.3 c	291.7 a	393.7 a
4	Revolver 22.5 SC	0.2 oz	6/4/03: late			362.7 ab	271.3 a	305.3 a
5	Revolver 22.5 SC	0.4 oz	6/4/03: late			363.3 ab	272.7 a	304.7 a
6	Kerb WSP	1.1 oz	5/7/03: early	354 a	290 a	269 c	257.3 a	340 a
7	Kerb WSP	1.1 oz	6/4/03: late			366.3 a	326.3 a	340 a
8	Monument 75 WG	0.0046 oz	5/7/03: early	309 a	220.3 b	264.3 c	280.7 a	385.3 a
9	Monument75 WG	0.0046 oz	6/4/03			373.3 a	308.3 a	350.3 a