Tolerance of different grass species to repeated application of NEU1173H – Spring 2010 trial.

K. Carey, A.J. Porter, E.M. Lyons and K.S. Jordan

Department of Plant Agriculture and the Guelph Turfgrass Institute,
University of Guelph, Ontario.

MATERIALS/METHODS

Plots were located in turf research area at the Guelph Turfgrass Institute, Guelph, ON. The sites were areas of established turf: several years old in the case of Kentucky bluegrass (Figure 1) and fine fescue (Figure 2); newly established in the case of perennial ryegrass (Figure 3). Turf was maintained with typical high maintenance turf regime: 1.5 kg actual N 100 m^{-2} per year in 3 applications (spring, summer, dormant); P and K in a 4:1:4 ratio with N; irrigated to prevent stress prior to treatment application and to prevent dormancy thereafter; mowed at 3 inches.

The treatments were combinations of different rates and volumes of post-emergent herbicide, as well as controls for a total of 7 treatments (see Table 1). Each treatment was replicated four times in 1 x 2 m plots arranged in a randomized complete block design. Treatments were applied in according to the schedule in Table 1. Treatments were applied with a compressed air sprayer (100 ml m^{-2} spray volume; Teejet 8001VS flat fan nozzles - 5 ml/sec/nozzle at 20 psi).

An anecdotal photographic record of the experiment was kept.

All measurements were analysed by appropriate statistical analyses (general linear models).

Data Collection: Plots were rated pre- and post-treatment for turf color and quality, using visual assessments and canopy reflectance (normalized-difference vegetation index). Weed presence was assessed pre- and post-treatment with visual ratings.

Phytotoxicity of treatments to plots (turfgrass and weeds) was assessed by visual ratings and NDVI.

Figure 1. Kentucky bluegrass plot area June 28, 2010.

Figure 2. Fine fescue plot area June 28, 2010.

Figure 3. Perennial ryegrass plot area June 28, 2010.

RESULTS

Environmental data. Rainfall and temperature data were recorded at the Environment Canada weather station in the research ranges at the GTI (Figures 4 and 5). The season was wetter than average, with ~500 mm of rainfall during the course of the experiment. Temperatures were slightly below normal for summer in Guelph, with only four days above 30°C.

Phytotoxicity – visual ratings. There was no visible phytotoxicity of the treatments within the first day or two of application on any of the three species turfgrass as assessed by visual ratings, although the typical darkening of the Fiesta was observed in all three species (Table 2). Subsequent applications produced a significant thinning effect on the turf density in the Kentucky bluegrass and perennial ryegrass, but not in the fine fescue. There was some weed growth in all of the treatments in Kentucky bluegrass and fine fescue plots, including the Par III. Among the Fiesta treatments the amount of weed growth was related to rate of application. There was no weed growth in the perennial ryegrass plots, other than the untreated control.

An outbreak of rust occurred in late July in the perennial ryegrass plots. The plots were fertilized (5 g m^{-2} actual N as 19-0-15 NutriDG) on July 20, and treated with azoxystrobin (60 ml 100 m^{-2} in 80 ml solution m^{-2}) to control rust. Both before and after the rust control treatments, there

Table 1. Treatments

Treatment		Rate	Application schedule
1	Control	—	—
2	PAR III	(0.55 ml m^{-2})	once
3	4x3		4 times, 3 week interval
4	8x2	NEU1173H	8 times, 2 week interval
5	S2F2	(1 g a.i. m^{-2})	2 times spring, 2 times fall, 2 week interval
6	S3F3	400 ml m^{-2}	3 times spring, 3 times fall, 2 week interval
7	S4F4		4 times spring, 3 times fall, 2 week interval

Application	4x3			8x2			S2F2			S3F3			S4F4		
date	KB	FF	PR	KB	FF	PR	KB	FF	PR	KB	FF	PR	KB	FF	PR
06/03	★			★			★			★			★		
06/07		★			★			★			★			★	
06/18				★	★										
06/25	★	★					★	★		★	★		★	★	
06/28			★			★			★			★			★
07/02				★	★										
07/13						★									
07/16	★	★	★	★	★				★	★	★	★	★	★	★
07/26						★									
07/30				★	★										
08/06	★	★	★			★						★	★	★	★
08/13				★	★										
08/20						★									
08/26			★	★	★								★	★	★
09/03						★									
09/13				★	★										
09/20						★						★	★	★	★
10/01						★									
10/07										★	★		★	★	
10/08									★			★			★

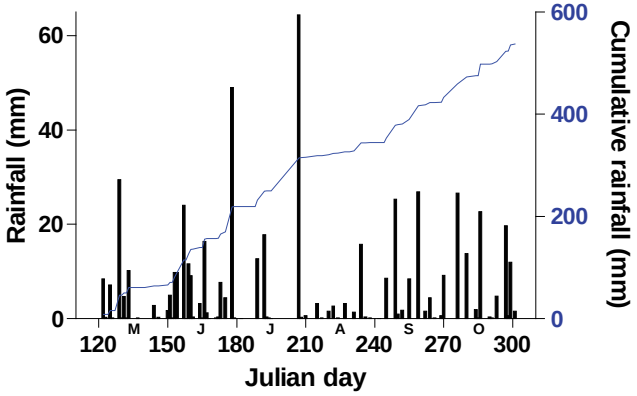

Figure 4. Daily and cumulative precipitation – summer 2010 Data are from the Environment Canada weather station at the GTI.

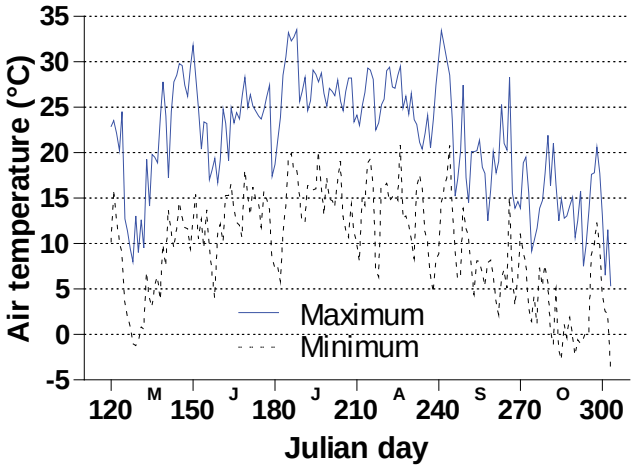

Figure 5. Daily maximum and minimum air temperatures – summer 2010. Data are from the Environment Canada weather station at the GTI.

was significantly less infection on all of the Fiesta treated plots than on either the Par III or untreated plots (Figure 6).

Crop tolerance – canopy reflectance. Canopy reflectance, which can be correlated with photosynthetic activity and plant health, was reduced by all treatments relative to the control (Tables 3 - 5). There was a rate effect apparent in the experimental treatments, with higher rates producing a larger decline. Since the canopy reflectance readings are affected by many stresses,it is possible that some of the decline in NDVI values was due to rust infection in the perennial ryegrass plots. Generally the decline in

Figure 6. Rust infection on perennial ryegrass plots not treated with Fiesta – July 21, 2010.

Table 2. Visual ratings of turf performance characteristics.

	Fine fescue						
	06/28				08/26		
Treatment	Color	Phytotoxicity	Quality	Weeds	Quality	Weeds	Density
4X3	8.00[1]	0.00	8.00	0.00	7.00	0.00 b	9.50
8X2	7.00	0.00	8.00	0.00	7.00	0.00 b	9.75
Control	7.00	0.00	8.00	0.00	7.00	1.00 a	10.00
Par III	6.75	0.00	8.00	0.00	7.00	0.25 ab	10.00
S2F2	8.25	0.00	8.00	0.00	7.00	0.75 ab	9.75
S3F3	8.00	0.00	8.00	0.00	7.00	0.25 ab	9.75
S4F4	7.50	0.00	8.00	0.00	7.00	0.00 b	9.50
msd p=0.05	NS	NS	NS	NS	NS	0.86	NS
	Kentucky bluegrass						
	06/28				08/26		
Treatment	Color	Phytotoxicity	Quality	Weeds	Quality	Weeds	Density
4X3	8.00 b	0.00	8.00	0.25 b	8.00	0.00 c	8.50 b
8X2	9.00 a	0.00	8.00	0.00 b	8.00	0.25 c	7.50 b
Control	7.00 c	0.00	8.00	3.00 a	8.00	2.25 a	10.00 a
Par III	7.25 bc	0.00	8.00	0.50 b	8.00	1.50 ab	10.00 a
S2F2	7.75 bc	0.00	8.00	0.50 b	8.00	1.75 ab	10.00 a
S3F3	8.00 b	0.00	8.00	0.00 b	8.00	1.00 bc	10.00 a
S4F4	8.00 b	0.00	8.00	0.50 b	8.00	1.00 bc	8.75 ab
msd p=0.05	0.85	NS	NS	1.49	NS	1.18	1.29
					Perennial ryegrass		
					08/26		
Treatment					Quality	Weeds	Density
4X3					6.25	0.00 b	7.50 ab
8X2					5.00	0.00 b	5.00 c
Control					6.25	0.75 a	8.00 ab
Par III					7.50	0.00 b	8.75 a
S2F2					6.75	0.00 b	8.00 ab
S3F3					6.50	0.00 b	7.50 ab
S4F4					5.75	0.00 b	6.00 bc
msd p=0.05					NS	0.44	2.13

[1] Visual ratings 0 - 10, 10 = best color, quality, or density, 10 = most phytotoxicity or weed presence. Means of 4 replicates. Means within columns followed by the same letter are not significantly different (Tukey's HSD test, p=0.05).

Table 3. Canopy reflectance of treated plots – Fine fescue.

Treatment	05/10	05/17	05/25	05/27	05/31	06/01	06/04	06/08	06/11	06/14
Control	0.495 b[1]	0.474 bc	0.534 a	0.294 bc	0.364 b	0.415 bc	0.411 ab	0.485 a	0.431 abc	0.385 ab
S2F2	0.504 ab	0.497 a	0.527 a	0.319 a	0.395 a	0.440 a	0.405 abc	0.431 bc	0.411 cde	0.381 abc
Par III	0.494 b	0.474 bc	0.535 a	0.308 ab	0.389 ab	0.401 cd	0.400 bc	0.485 a	0.447 a	0.390 ab
8X2	0.519 a	0.490 ab	0.536 a	0.260 d	0.407 a	0.421 ab	0.395 c	0.420 d	0.437 ab	0.395 a
S3F3	0.505 ab	0.478 abc	0.534 a	0.324 a	0.391 ab	0.422 ab	0.417 a	0.439 b	0.401 e	0.378 abc
S4F4	0.491 b	0.474 bc	0.511 b	0.304 ab	0.391 ab	0.411 bc	0.401 bc	0.433 bc	0.423 bcd	0.372 bc
4X3	0.488 b	0.459 c	0.503 b	0.276 cd	0.382 ab	0.388 d	0.380 d	0.426 cd	0.409 de	0.360 c
msd p=0.05	0.021	0.02	0.014	0.023	0.029	0.02	0.014	0.01	0.021	0.022
	06/19	06/21	06/28	07/02	07/06	07/14	07/16	07/19	07/23	07/27
Control	0.396 a	0.394 bc	0.509 b	0.545 a	0.483 a	0.418 abc	0.488 ab	0.546 ab	0.473 a	0.418 a
S2F2	0.392 ab	0.386 c	0.508 b	0.520 b	0.470 ab	0.428 a	0.497 a	0.549 a	0.473 a	0.414 a
Par III	0.376 bc	0.394 bc	0.498 b	0.521 b	0.451 c	0.413 bcd	0.475 bc	0.523 cd	0.465 ab	0.414 a
8X2	0.389 ab	0.398 bc	0.526 a	0.539 a	0.451 c	0.411 cd	0.478 bc	0.534 bc	0.434 c	0.389 b
S3F3	0.387 ab	0.416 a	0.507 b	0.498 c	0.458 bc	0.419 abc	0.486 ab	0.517 de	0.431 c	0.379 b
S4F4	0.363 c	0.397 bc	0.507 b	0.501 c	0.468 b	0.426 ab	0.489 ab	0.523 cd	0.453 b	0.410 a
4X3	0.375 bc	0.402 ab	0.503 b	0.491 c	0.447 c	0.403 d	0.469 c	0.507 e	0.437 c	0.394 b
msd p=0.05	0.0177	0.0149	0.0146	0.0123	0.0151	0.0146	0.0137	0.0127	0.014	0.0165
	08/03	08/09	08/19	08/26	08/30	09/14	09/20	09/23	09/27	10/11
Control	0.478 a	0.469 a	0.479 a	0.496 ab	0.473 abc	0.506 ab	0.567 c	0.526 c	0.576 b	0.597 c
S2F2	0.431 c	0.464 ab	0.476 a	0.507 a	0.481 a	0.517 a	0.590 ab	0.576 a	0.604 a	0.622 ab
Par III	0.452 b	0.470 a	0.487 a	0.507 a	0.479 ab	0.515 ab	0.584 b	0.553 b	0.607 a	0.626 ab
8X2	0.449 b	0.442 cd	0.471 ab	0.484 b	0.465 cde	0.466 e	0.535 e	0.507 d	0.570 bc	0.617 b
S3F3	0.396 d	0.451 bcd	0.459 b	0.486 b	0.456 de	0.490 cd	0.554 d	0.551 b	0.602 a	0.583 d
S4F4	0.425 c	0.457 abc	0.441 c	0.471 c	0.459 cd	0.503 bc	0.596 a	0.525 c	0.561 c	0.571 e
4X3	0.408 d	0.434 d	0.420 d	0.451 d	0.444 e	0.482 d	0.566 cd	0.553 b	0.594 a	0.631 a
msd p=0.05	0.0155	0.0178	0.017	0.0132	0.0145	0.0136	0.0124	0.0142	0.0125	0.0102

[1]Normalized-difference vegetation index: mean of ~50 readings x 4 replicates; means within columns followed by the same letter are not significantly different (Tukey's HSD test, p=0.05).

Table 4. Canopy reflectance of treated plots – Kentucky bluegrass.

Treatment	05/10	05/17	05/25	05/27	05/31	06/01	06/04	06/05	06/08	06/11	06/14
Par III	0.539 b[1]	0.516 b	0.630 c	0.605 ab	0.621 ab	0.643 ab	0.624 ab	0.565 a	0.619 b	0.586 a	0.537 c
Control	0.537 b	0.536 a	0.635 bc	0.609 ab	0.605 c	0.639 ab	0.626 a	0.571 a	0.630 a	0.586 a	0.566 a
S2F2	0.579 a	0.539 a	0.642 abc	0.597 b	0.622 a	0.638 ab	0.616 bc	0.535 c	0.595 c	0.568 b	0.511 d
S3F3	0.555 b	0.538 a	0.641 abc	0.598 ab	0.609 bc	0.648 a	0.628 a	0.562 a	0.621 ab	0.583 a	0.542 bc
4X3	0.544 b	0.528 ab	0.652 a	0.593 b	0.611 abc	0.636 b	0.615 c	0.542 bc	0.593 c	0.553 c	0.557 ab
S4F4	0.552 b	0.543 a	0.646 ab	0.615 a	0.613 abc	0.641 ab	0.616 bc	0.546 bc	0.596 c	0.574 ab	0.531 c
8X2	0.555 b	0.529 ab	0.636 bc	0.603 ab	0.618 ab	0.642 ab	0.632 a	0.547 b	0.600 c	0.580 ab	0.544 bc
msd p=0.05	0.022	0.0188	0.0134	0.0171	0.0125	0.0126	0.0084	0.0112	0.0095	0.0135	0.0174
	06/19	06/21	06/28	07/02	07/06	07/12	07/14	07/16	07/19	07/23	07/27
Par III	0.565 b	0.568 d	0.645 a	0.680 a	0.631 a	0.694 a	0.611 a	0.651 ab	0.689 a	0.661 a	0.618 a
Control	0.571 b	0.596 a	0.648 a	0.682 a	0.637 a	0.694 a	0.583 bc	0.637 bc	0.681 ab	0.638 b	0.606 b
S2F2	0.557 b	0.568 d	0.629 bcd	0.663 b	0.615 b	0.673 bc	0.594 b	0.633 bcd	0.675 b	0.611 c	0.579 c
S3F3	0.591 a	0.574 cd	0.634 b	0.657 bc	0.632 a	0.688 a	0.618 a	0.650 a	0.628 c	0.552 e	0.550 e
4X3	0.567 b	0.593 ab	0.630 bc	0.653 cd	0.618 b	0.675 b	0.575 c	0.642 ab	0.630 c	0.562 d	0.562 d
S4F4	0.562 b	0.582 bc	0.621 cd	0.647 d	0.605 c	0.665 c	0.578 c	0.623 d	0.614 d	0.530 f	0.535 f
8X2	0.561 b	0.484 e	0.619 d	0.651 cd	0.544 d	0.651 d	0.585 bc	0.627 cd	0.628 c	0.508 g	0.525 f
msd p=0.05	0.014	0.0114	0.0099	0.0075	0.0091	0.0081	0.0127	0.011	0.0107	0.0096	0.0113
	08/03	08/09	08/19	08/26	08/30	09/14	09/20	09/23	09/27	10/11	
Par III	0.636 a	0.635 a	0.579 a	0.592 a	0.587 a	0.588 a	0.592 a	0.566 b	0.562 ab	0.508 c	
Control	0.620 b	0.611 b	0.542 b	0.570 b	0.561 b	0.576 bc	0.594 a	0.574 ab	0.571 a	0.528 b	
S2F2	0.596 d	0.591 c	0.545 b	0.570 b	0.555 b	0.577 b	0.589 a	0.569 b	0.564 ab	0.509 c	
S3F3	0.612 bc	0.583 c	0.503 c	0.534 c	0.529 c	0.584 ab	0.589 a	0.580 a	0.565 ab	0.479 d	
4X3	0.608 c	0.533 e	0.444 d	0.500 d	0.527 c	0.579 b	0.593 a	0.574 ab	0.568 a	0.531 b	
S4F4	0.556 e	0.483 f	0.405 e	0.489 d	0.456 d	0.568 c	0.588 a	0.541 d	0.557 b	0.512 c	
8X2	0.559 e	0.565 d	0.398 e	0.417 e	0.383 e	0.538 d	0.545 b	0.558 c	0.565 ab	0.593 a	
msd p=0.05	0.0115	0.0107	0.0163	0.0124	0.0131	0.0089	0.0107	0.0082	0.011	0.0122	

[1]Normalized-difference vegetation index: mean of ~50 readings x 4 replicates; means within columns followed by the same letter are not significantly different (Tukey's HSD test, p=0.05).

Table 5. Canopy reflectance of treated plots – Perennial ryegrass.

Treatment	06/18	06/19	06/28	06/30	07/02	07/06	07/14	07/16	07/19	07/23	07/27
S4F4	0.600 ab[1]	0.560 a	0.638 b	0.579 c	0.573 b	0.495 b	0.484 c	0.468 f	0.441 a	0.541 a	0.534 a
4X3	0.579 bc	0.557 a	0.649 a	0.616 a	0.604 a	0.537 a	0.526 a	0.506 bc	0.427 a	0.518 b	0.539 a
Par III	0.508 d	0.495 c	0.634 bc	0.603 b	0.597 a	0.542 a	0.534 a	0.524 a	0.428 a	0.474 c	0.516 b
Control	0.576 bc	0.535 b	0.632 bc	0.597 b	0.596 a	0.526 a	0.498 b	0.501 cd	0.403 b	0.471 c	0.512 b
S3F3	0.583 bc	0.534 b	0.626 c	0.550 e	0.533 d	0.462 c	0.499 b	0.488 e	0.382 c	0.476 c	0.519 b
S2F2	0.561 c	0.527 b	0.634 bc	0.577 c	0.556 c	0.477 bc	0.498 b	0.516 ab	0.390 bc	0.473 c	0.514 b
8X2	0.615 a	0.557 a	0.611 d	0.559 d	0.555 c	0.473 c	0.482 c	0.493 de	0.363 d	0.431 d	0.480 c
msd p=0.05	0.0253	0.0198	0.0097	0.0087	0.0134	0.0201	0.0109	0.0129	0.0166	0.015	0.0132
	08/03	08/09	08/19	08/26	08/30	09/14	09/20	09/23	09/27	10/11	07/27
S4F4	0.520 e	0.500 b	0.472 a	0.435 a	0.407 a	0.470 a	0.511 a	0.473 a	0.466 a	0.499 a	
4X3	0.611 ab	0.507 b	0.408 c	0.375 d	0.304 cd	0.420 cd	0.481 b	0.473 a	0.457 a	0.457 b	
Par III	0.625 a	0.540 a	0.407 c	0.405 c	0.297 d	0.441 b	0.482 b	0.467 a	0.459 a	0.472 b	
Control	0.597 bc	0.556 a	0.459 ab	0.410 bc	0.336 b	0.397 e	0.426 d	0.422 b	0.409 b	0.406 c	
S3F3	0.563 d	0.499 b	0.389 c	0.403 c	0.305 cd	0.443 b	0.520 a	0.480 a	0.469 a	0.520 a	
S2F2	0.604 bc	0.551 a	0.451 b	0.421 ab	0.323 bc	0.411 de	0.439 cd	0.423 b	0.413 b	0.396 c	
8X2	0.589 c	0.492 b	0.462 ab	0.432 a	0.312 cd	0.428 bc	0.455 c	0.414 b	0.402 b	0.414 c	
msd p=0.05	0.0194	0.0216	0.0209	0.015	0.0217	0.0175	0.0198	0.0183	0.0207	0.0216	

[1]Normalized-difference vegetation index: mean of ~50 readings x 4 replicates; means within columns followed by the same letter are not significantly different (Tukey's HSD test, p=0.05).

canopy reflectance associated with Fiesta application disappeared two weeks after the most recent treatment application (Figures 7 - 9), except in the higher frequency applications such as S4F4 and 8x2 in Kentucky bluegrass, where the post-treatment recovery did not quite reach control levels before the next application. The declines in canopy reflectance in treated plots, while statistically significant, were not associated with significant declines in visual turf quality, and by the end of the season the NDVI ratings were equal to or better than the untreated control plots.

DISCUSSION AND CONCLUSIONS

All three turfgrass species had slight reductions in canopy reflectance with applications of 400 ml m-2 of Fiesta, but with the exception of the higher rates (8x2 and S4F4) the decline disappeared during the interval between applications (2 or 3 weeks). The declines were slight in absolute terms, and not accompanied by any visual decline in turf quality. Fiesta treatments lead to a darker green color, whereas normally a decline in turf canopy reflectance, for example caused by N deficiency, drought stress, or phytotoxicity, is accompanied by yellowing or chlorosis. In all treatments the turf had fully recovered to untreated control levels of canopy reflectance or better by the end of the season.

There was some evidence of reduction of turf density at higher rates in the Kentucky bluegrass and perennial ryegrass plots. In Kentucky bluegrass this was seen as a coarsening in leaf texture, which normally accompanies reduced tiller counts; there was no loss of cover. In the perennial ryegrass, which was a young (6 week) stand at the time of first application, the density reduction showed up as a slight delay in thickening of the stand (tiller production) at high rates.

All rates of Fiesta controlled an outbreak of leaf rust in the perennial ryegrass plots. This effect was not quantified, but there was no rate effect among the Fiesta treatments.

Sponsor: Neudorff North America

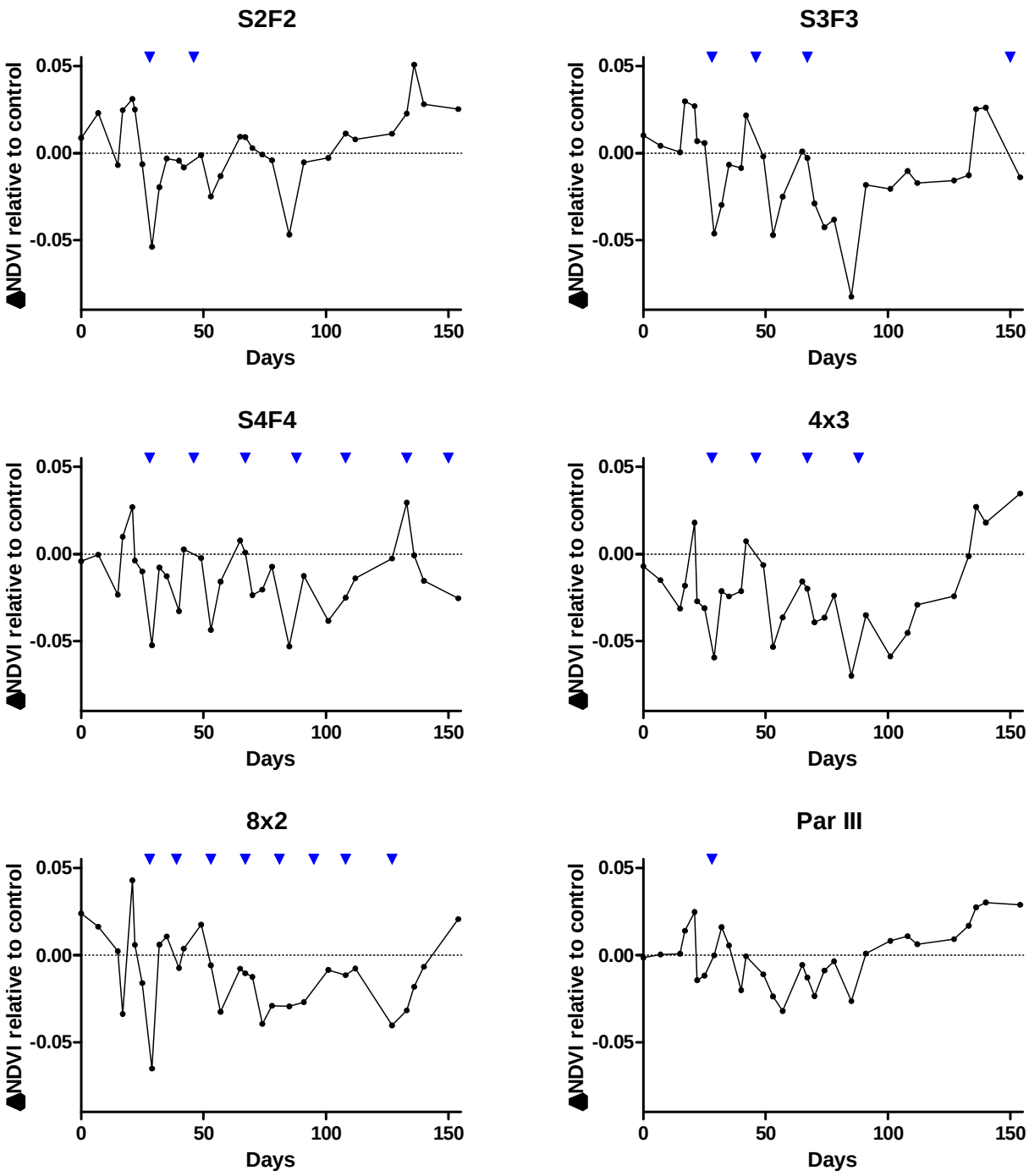

Figure 7. Changes in canopy reflectance in treated plots of fine fescue relative to untreated check. Application dates are indicated by blue arrows.

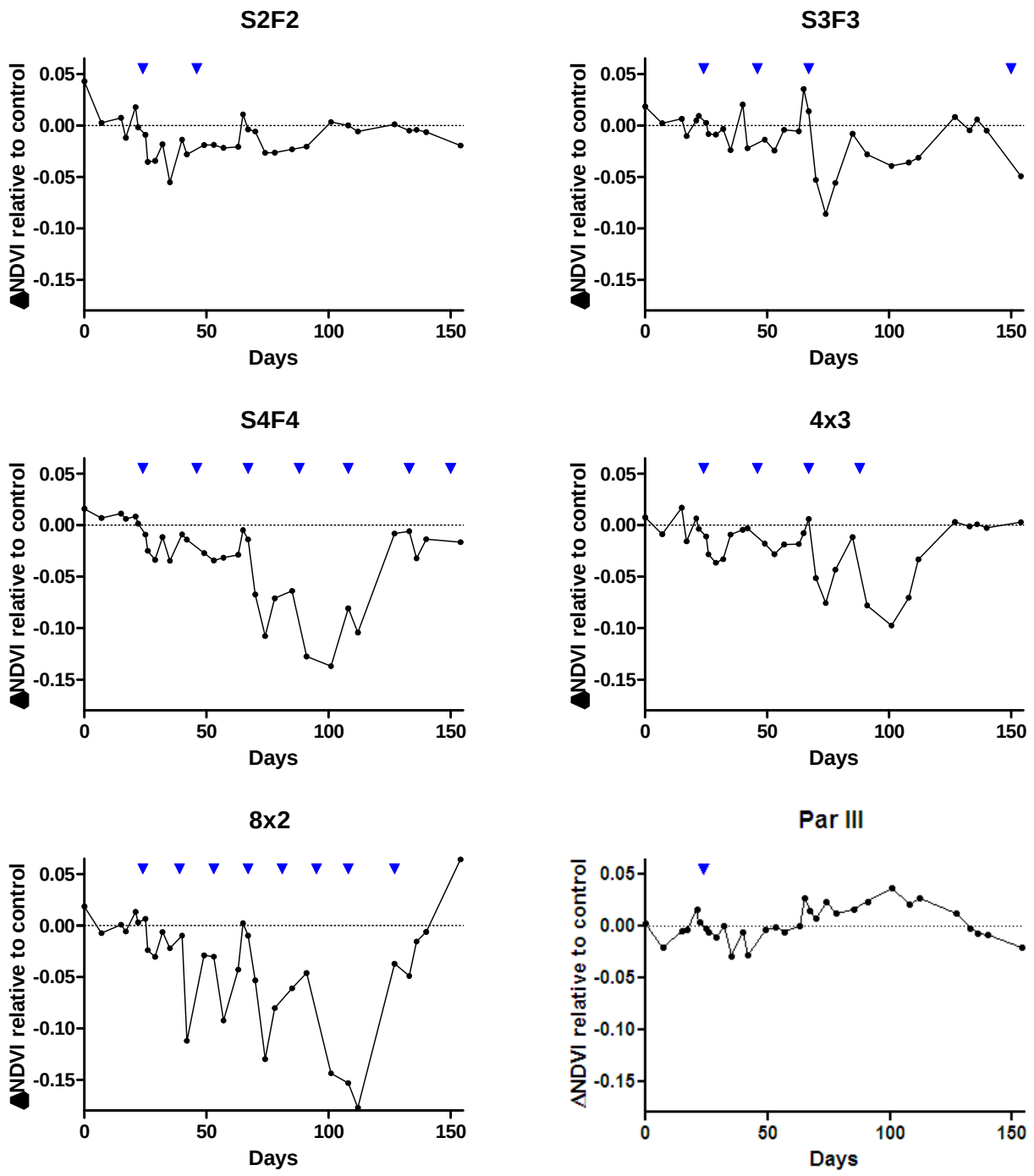

Figure 8. Changes in canopy reflectance in treated plots of Kentucky bluegrass relative to untreated check. Application dates are indicated by blue arrows.

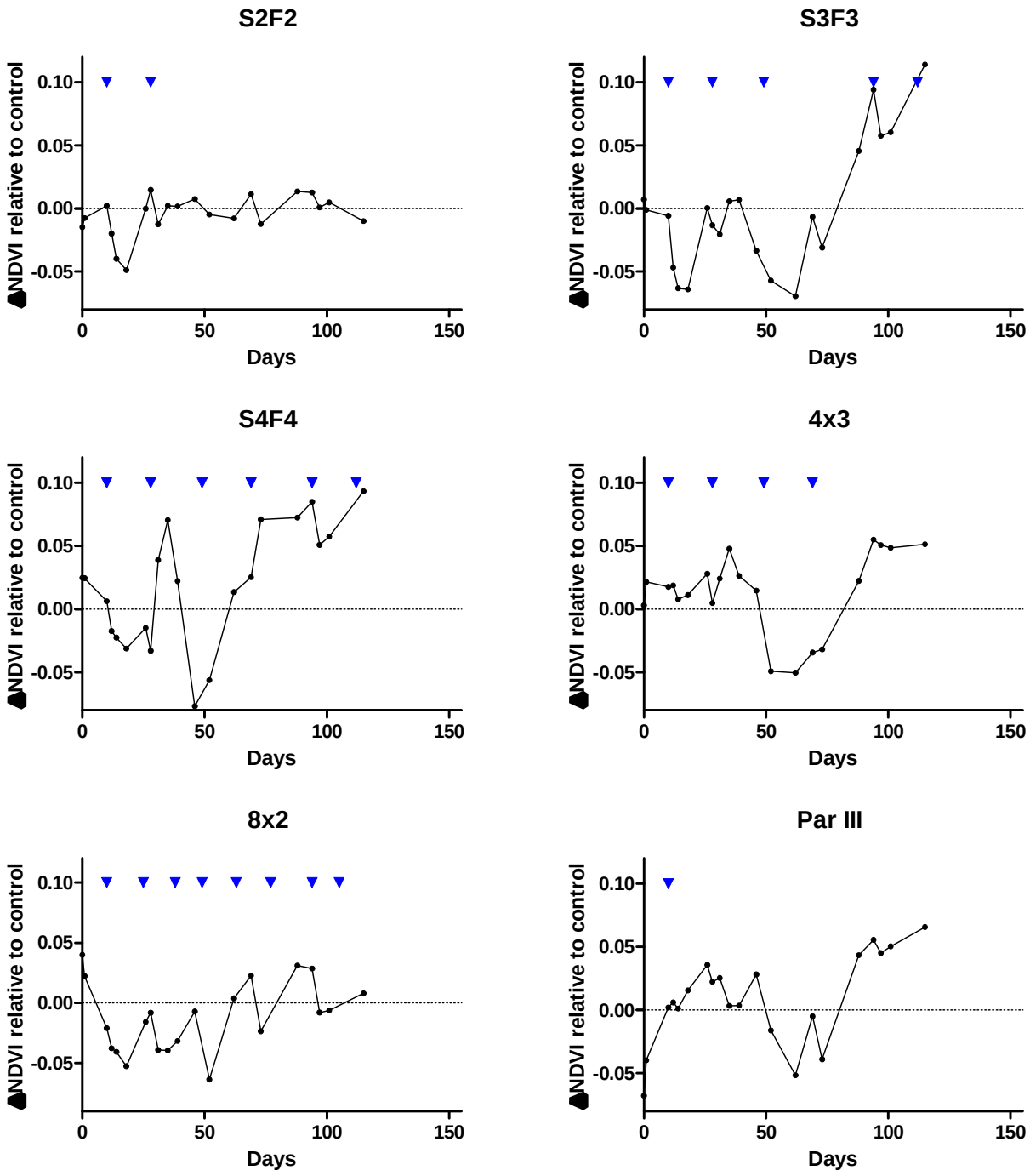

Figure 9. Changes in canopy reflectance in treated plots of perennial ryegrass relative to untreated check. Application dates are indicated by blue arrows.