Evaluation of turfgrass seed mixtures under low input and standard home lawn maintenance regimes

E. Lyons, K. Jordan, and K. Carey

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

Sponsor: Scotts

The objective of this research is to evaluate and compare plots established with various turf seed mixtures in a low input non-irrigated trial and in a trial with typical proper home lawn maintenance.

Data collection over the course of the trial will include visual weed invasion (species composition and cover estimates) visual turfgrass quality, visual color ratings, normalized difference vegetative index (NDVI), drought induced dormancy and recovery. Resistance to disease and insect pressures will be evaluated if they occur. Data collected in 2014 was germination, establishment and cover development data, as well as visual estimates of weed pressure and grass density.

MATERIALS / METHODS

Plots are located in the turf research area at the Guelph Turfgrass Institute, Guelph, ON. Plots (1.5 x 1.5 m) of each grass type were established by seed on July 14, 2014. The experiment included 17 mixtures replicated 4 times and laid out in a randomized block design, one set of plots for low-input and one set for standard maintenance (Table 1, Figure 1).

Table 1. Seed mixtures.

Treatment	Application rate[1] (g m^{-2})
A	457.5
B	133.3
C	17.1
D	33.3
E	32.3
F	25.0
G	15.0
H	53.8
I	12.2
J	20.0
K	15.2
L	20.0
M	20.0
O	44.4
P	37.5
Q	21.3
R	44.1

[1]Mixtures included some with seed only, some with coated seed, and some with seed and mulch.

Figure 1. Trial area one week after seeding (July 21, 2014). Nearer plots are the low maintenance trial; farther plots are the high maintenance trial.

Mixtures were seeded at recommended rates, and a starter fertilizer added at seeding (8-32-16 at 5 g m^{-2} P_2O_5). Turf was maintained with typical post seeding irrigation to promote germination and establishment, but no fertility beyond the starter fertilizer until the maintenance treatments proper begin. Plots were mowed weekly at 9 cm beginning 6 weeks after seeding. Standard maintenance plots were treated with selective (broadleaf) herbicide (Par III, 0.55 ml m^{-2}) at 5 weeks after seeding (August 19, 2014), irrigated to prevent stress and fertilized with 5 g m^{-2} actual nitrogen in a 25-4-10 complete analysis fertilizer on August 25, 2014. Low input plots received no herbicide treatments, no irrigation beyond establishment and no fertilizer treatments.

Once established the plots were rated visually for germination, establishment and cover development, and canopy reflectance (NDVI) was also recorded regularly. Weed invasion (visual cover estimates) was rated during establishment. No insect or disease pressure was noted.

Because of the cool wet summer, it was not possible to make observations on drought and drought recovery.

An anecdotal photographic record of the experiment was kept.

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

RESULTS

Environmental data

Daily air temperatures, evapotranspiration demand, and rainfall data for summer 2014 are presented in Figures 2 - 4.

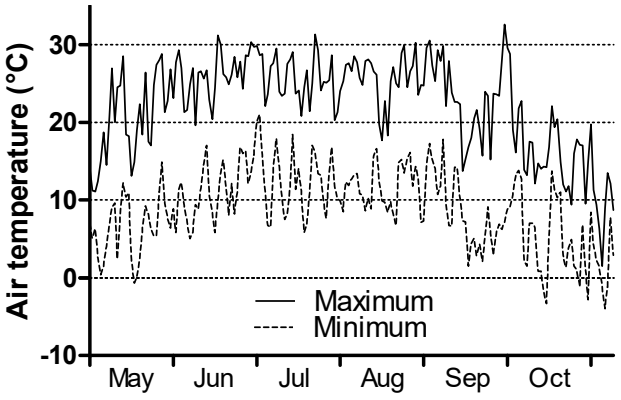

Figure 2. Daily air temperatures at GTI, summer 2014.

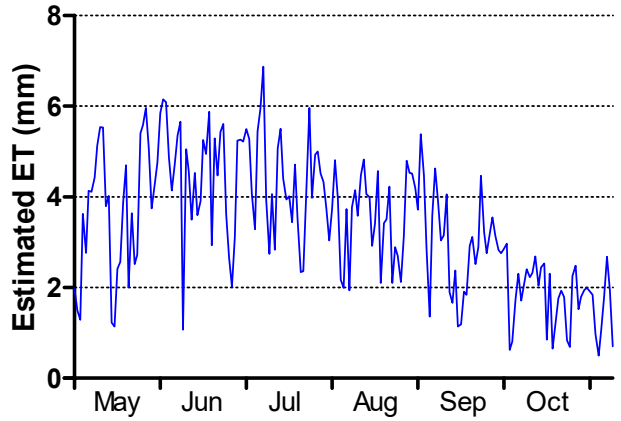

Figure 3. Daily estimated ET at GTI, summer 2014.

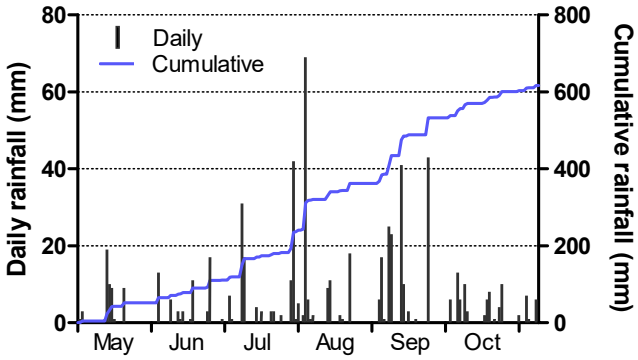

Figure 4. Daily and cumulative rainfall at GTI, summer 2014.

Germination and cover development

Visual ratings. The earliest germination in plots was noted at 5 days after seeding (DAS). At this time there was not enough germination to rate the plots. By 7 DAS there was germination in all the plots (Table 2). Species differences and seeding rate density differences were reflected in the increase in height and the density of the turf, so these two aspects of germination were assessed independently. Some treatments, such as mix H, had fast growing seedlings and dense cover. Others, such as mix A, had high densities, but relatively short seedlings.

Table 2. Visual rating of germination characteristics.

	Height[1]				Density[1]			
	Standard	Low	Standard	Low	Standard	Low	Standard	Low
Treatment	7 DAS		9 DAS		7 DAS		9 DAS	
A	1.0 cd	1.0 bc	1.3 bcd	1.0 bcd	3.0 a	2.8 a	3.0 a	3.0 a
B	1.0 cd	0.8 bcd	1.0 cd	1.0 bcd	1.0 c	0.8 cde	1.0 cde	1.0 b
C	1.0 cd	0.8 bcd	1.0 cd	1.0 a-d	1.0 c	0.8 cde	1.0 cde	0.8 b
D	1.0 cd	1.0 bc	1.3 bcd	1.0 bcd	1.0 c	1.0 cd	1.3 bcd	1.3 ab
E	2.0 ab	1.3 b	1.8 abc	1.0 bcd	1.5 bc	1.0 cd	1.3 bcd	1.0 b
F	0.8 cde	0.8 bcd	1.0 cd	1.0 bcd	1.0 c	0.8 cde	1.0 cde	1.3 ab
G	1.5 bc	1.5 b	1.3 bcd	1.5 abc	1.3 c	1.0 cd	1.0 cde	1.0 b
H	2.3 ab	2.8 a	2.3 a	2.0 a	2.3 ab	2.0 ab	3.0 a	2.3 ab
I	1.0 cd	1.0 bc	1.0 cd	1.3 abc	1.0 c	1.0 cd	1.0 cde	1.0 b
J	2.5 a	1.5 b	2.0 ab	1.8 ab	1.8 bc	1.0 cd	1.3 bcd	1.0 b
K	1.0 cd	1.0 bc	1.0 cd	1.0 bcd	1.0 c	1.0 cd	1.0 cde	1.0 b
L	0.8 cde	0.8 bcd	0.8 de	1.0 bcd	1.0 c	0.8 cde	0.8 def	1.0 b
M	1.0 cd	1.0 bc	1.0 cd	0.8 bcd	1.0 c	1.0 cd	1.0 cde	0.8 b
O	0.3 de	0.8 bcd	1.0 cd	0.8 cd	1.0 c	1.0 cd	2.0 b	1.8 ab
P	1.0 cd	1.0 bc	1.0 cd	1.0 bcd	1.5 bc	1.3 bc	1.5 bcd	1.0 b
Q	2.3 ab	1.5 b	1.8 abc	1.3 abc	1.8 bc	1.3 bc	1.8 bc	1.0 b
R	0.6 de	0.3 cd	0.1 e	0.6 cd	0.8 cd	0.3 de	0.1 ef	0.6 b
unseeded	0.0 e	0.0 d	0.0 e	0.3 d	0.0 d	0.0 e	0.0 f	0.8 b
msd p=0.05	0.9	1.0	0.8	1.0	1.0	0.9	0.9	1.8

[1] Height and density of seedlings rated on a scale of 0 – 10, 10 being tallest or most dense.
[2] Mean of 4 replicates; means within columns followed by the same letter are not significantly different (Tukeys's HSD, p=0.05)

By 20 DAS some of the plots had developed complete cover, but there were significant differences among the treatments (Figure 5, Table 3). The fertilization of the Standard

Table 3. Visual rating of density[1] of grass cover.

Treatment	20 DAS		27 DAS		50 DAS		62 DAS	
	Standard	Low	Standard	Low	Standard	Low	Standard	Low
A	8.0 ab[2]	8.3 a	8.8 ab	9.3 ab	9.5 a	9.8 ab	10.0 a	9.8 ab
B	6.3 c-f	5.5 cde	6.3 c-h	7.3 b-f	9.3 ab	8.3 a-d	9.0 a-d	8.8 a-d
C	4.5 ghi	4.8 cde	5.0 gh	6.3 d-g	8.5 a-d	7.5 cd	8.5 b-e	8.8 a-d
D	6.8 b-e	6.3 bcd	6.5 c-g	8.0 a-e	9.0 abc	8.0 bcd	9.5 ab	8.8 a-d
E	6.5 b-f	5.8 cde	6.3 c-h	7.0 c-f	8.8 abc	8.5 a-d	8.5 b-e	8.3 a-d
F	4.3 hi	4.5 de	4.8 h	5.8 fg	7.5 cde	7.5 cd	8.3 b-e	7.5 de
G	6.5 b-f	6.3 bcd	7.8 bc	8.3 a-d	9.5 a	8.5 a-d	9.0 a-d	8.8 a-d
H	9.0 a	8.0 ab	9.5 a	9.8 a	10.0 a	10.0 a	10.0 a	10.0 a
I	5.0 f-i	4.8 cde	5.3 fgh	5.8 fg	8.5 a-d	8.0 bcd	8.0 cde	8.0 b-e
J	7.3 bc	6.5 abc	7.3 bcd	8.5 abc	9.5 a	8.8 a-d	9.0 a-d	9.5 abc
K	6.3 c-f	5.5 cde	6.8 c-f	7.5 b-f	9.0 abc	9.0 a-d	9.3 abc	8.8 a-d
L	3.8 ij	4.3 e	5.5 e-h	4.5 gh	7.0 de	7.3 d	7.8 de	9.0 a-d
M	5.5 d-h	5.5 cde	6.0 d-h	6.5 c-g	8.8 abc	8.3 a-d	8.8 a-e	8.5 a-d
O	5.3 e-i	5.3 cde	5.5 e-h	6.0 efg	7.8 b-e	7.3 d	8.8 a-e	7.8 cde
P	6.0 c-g	5.8 cde	6.0 d-h	7.3 b-f	9.0 abc	8.0 bcd	9.3 abc	8.3 a-d
Q	7.0 bcd	5.8 cde	7.0 cde	8.0 a-e	9.0 abc	9.3 abc	9.3 abc	9.3 a-d
R	2.3 jk	1.8 f	2.5 i	3.0 hi	6.8 e	5.3 e	7.5 e	6.3 e
unseeded	1.8 k	1.5 f	1.8 i	1.5 i	5.0 f	3.3 f	5.3 f	4.0 f
msd p=0.05	1.6	1.9	1.6	2.0	1.7	1.9	1.4	1.9

[1] Density of cover rated on a scale of 0 – 10, 0 = no grass, 10 = complete cover.
[2] Mean of 4 replicates; means within columns followed by the same letter are not significantly different (Tukeys's HSD, p=0.05)

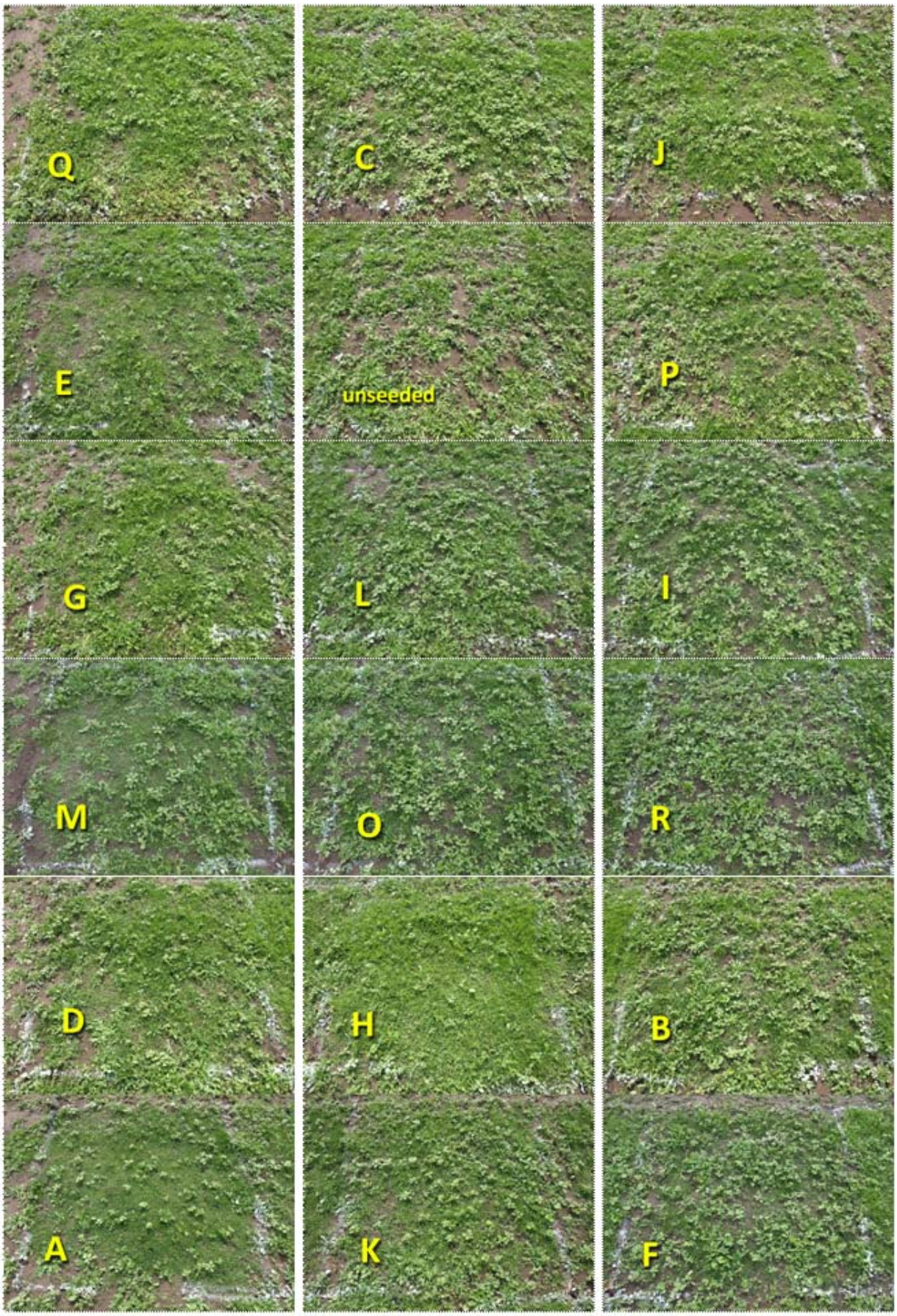

Figure 5. Images of 1.5 x 1.5 m plots in Block 1, standard maintenance, on August 12, 2014 (20 DAS).

maintenance treatment 42 DAS produced some increase in cover development relative to the Low maintenance treatment as measured 50 and 62 DAS, but the rankings among the mixtures remained consistent. Mixtures A and H were the best performing, and F and R had the poorest cover development. Visual ratings of weed pressure showed an inverse relationship, with the treatments showing the fastest cover development developing the least weed presence (Table 4).

Table 4. Weed presence[1] (visual ratings).

Treatment	Standard	Low	Standard	Low	Low	Low
	20 DAS		27 DAS		50 DAS	62 DAS
A	2.8 bcd	2.5 ef	2.3 bc[2]	2.0 de	2.5 cd	2.3 cd
B	4.3 b	4.0 bc	4.0 ab	4.0 bc	3.8 bc	3.3 c
C	3.8 bc	3.8 bcd	3.0 bc	4.0 bc	3.8 bc	3.8 bc
D	3.3 bc	3.5 b-e	3.0 bc	3.0 cd	3.5 bc	3.0 c
E	3.3 bc	3.3 cde	3.3 bc	3.0 cd	2.8 bcd	2.8 c
F	4.0 bc	3.5 b-e	3.8 ab	3.8 bc	4.0 b	3.5 c
G	3.3 bc	3.3 cde	2.5 bc	3.3 bcd	2.8 bcd	2.5 cd
H	1.5 d	2.0 f	1.5 c	1.5 e	1.5 d	1.0 d
I	4.3 b	4.0 b	3.5 b	4.3 bc	3.8 bc	3.8 bc
J	2.5 cd	3.0 c-f	2.3 bc	3.3 bcd	3.0 bc	2.8 c
K	3.8 bc	3.3 cde	3.8 ab	3.3 bcd	3.3 bc	3.3 c
L	3.8 bc	3.3 cde	3.8 ab	4.0 bc	4.0 b	3.3 c
M	3.3 bc	3.0 c-f	3.0 bc	3.3 bcd	3.0 bc	3.3 c
O	4.0 bc	3.0 c-f	3.3 bc	3.0 cd	3.8 bc	3.8 bc
P	3.3 bc	3.0 c-f	2.5 bc	3.0 cd	3.3 bc	2.8 c
Q	3.0 bcd	2.8 def	3.0 bc	3.3 bcd	3.0 bc	3.0 c
R	6.3 a	5.3 a	5.5 a	5.8 a	5.5 a	5.3 ab
unseeded	4.0 bc	4.5 ab	3.8 ab	4.5 ab	5.8 a	6.0 a
msd p=0.05	1.5	1.2	1.8	1.4	1.3	1.6

[1] Weed presence rated on a scale of 0 – 10, 0 = no weed, 10 = complete weed cover. Weeds were not present in the Standard maintenance treatment following the phenoxy herbicide spray 35 DAS.
[2] Mean of 4 replicates; means within columns followed by the same letter are not significantly different (Tukeys's HSD, p=0.05)

Canopy reflectance. Cover development was observed using canopy reflectance. Normalized-difference vegetation index (NDVI) increases with cover and can be used to estimate the development curve. There were no significant differences on any observation data among the treatments for canopy reflectance (Table 5), although there was a reduction noted in all Standard maintenance treatments following the phenoxy herbicide treatment 35 DAS. This is likely due to the combined effect of phytotoxicity on weeds and grasses.

Table 5. Canopy reflectance in plots.

Treatment	1 DAS	7	10	14	28	35	38	43	51
					Standard maintenance				
A	-0.136[1]	-0.110	-0.122	-0.014	0.288	0.463	0.511	0.506	0.538
B	-0.153	-0.144	-0.126	-0.008	0.339	0.523	0.558	0.575	0.594
C	-0.115	-0.095	-0.082	0.031	0.316	0.476	0.515	0.519	0.560
D	-0.069	-0.077	-0.063	0.051	0.446	0.591	0.614	0.615	0.618
E	-0.148	-0.118	-0.099	-0.007	0.352	0.494	0.509	0.501	0.544
F	-0.156	-0.139	-0.126	-0.048	0.280	0.461	0.493	0.496	0.544
G	-0.157	-0.146	-0.126	-0.011	0.348	0.506	0.528	0.538	0.572
H	-0.157	-0.133	-0.092	0.023	0.384	0.517	0.554	0.561	0.579
I	-0.151	-0.150	-0.129	-0.015	0.343	0.520	0.551	0.561	0.587
J	-0.155	-0.151	-0.124	0.024	0.380	0.551	0.572	0.575	0.591
K	-0.109	-0.102	-0.073	0.036	0.408	0.553	0.582	0.586	0.588
L	-0.159	-0.150	-0.127	-0.024	0.305	0.463	0.508	0.505	0.557
M	-0.149	-0.139	-0.127	0.005	0.330	0.513	0.524	0.511	0.547
O	-0.149	-0.114	-0.105	0.016	0.300	0.422	0.484	0.466	0.479
P	-0.147	-0.113	-0.072	0.020	0.378	0.512	0.534	0.539	0.571
Q	-0.159	-0.146	-0.101	0.002	0.398	0.564	0.558	0.565	0.594
R	-0.154	-0.134	-0.120	-0.001	0.362	0.523	0.543	0.551	0.570
msd p=0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS
					Low maintenance				
A	-0.146	-0.133	-0.099	0.007	0.378	0.572	0.601	0.611	0.595
B	-0.140	-0.117	-0.100	0.014	0.354	0.552	0.584	0.604	0.595
C	-0.122	-0.063	-0.073	-0.003	0.304	0.500	0.544	0.535	0.548
D	-0.131	-0.092	-0.045	0.028	0.423	0.599	0.597	0.601	0.587
E	-0.148	-0.112	-0.072	0.010	0.375	0.567	0.579	0.571	0.575
F	-0.144	-0.105	-0.090	-0.004	0.338	0.551	0.576	0.570	0.595
G	-0.084	-0.049	-0.042	0.066	0.347	0.509	0.545	0.541	0.582
H	-0.143	-0.125	-0.105	-0.002	0.339	0.556	0.572	0.575	0.578
I	-0.139	-0.067	-0.075	0.024	0.341	0.502	0.544	0.553	0.577
J	-0.134	-0.087	-0.069	0.043	0.381	0.548	0.570	0.561	0.576
K	-0.131	-0.099	-0.074	-0.007	0.278	0.497	0.511	0.475	0.535
L	-0.085	-0.049	-0.041	0.078	0.345	0.507	0.537	0.530	0.561
M	-0.095	-0.063	-0.062	0.040	0.345	0.534	0.573	0.566	0.601
O	-0.148	-0.103	-0.091	0.013	0.300	0.514	0.562	0.570	0.590
P	-0.148	-0.120	-0.102	-0.028	0.297	0.511	0.552	0.548	0.585
Q	-0.147	-0.099	-0.076	0.044	0.403	0.550	0.583	0.566	0.572
R	-0.139	-0.079	-0.081	0.003	0.271	0.459	0.503	0.505	0.542
msd p=0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS

1 NDVI value as measured by Ntech Greenseeker. Mean of ~60 readings per plot x 4 replicates.

The NDVI data can also be assessed by plotting growth curves (logistic curves of the general form $DNDVI = NDVI_{max} / 1+10^{((50\%NDVI\text{-}Days)*Slope\ factor)}$) fitted to the data. Figures 6 – 9 show curves fitted to the plot means of NDVI data.

Parameters of the fitted curves (maximum NDVI and days to 50% of maximum NDVI) can be compared by analysis of variance. Figures 10 and 11 show estimates of these parameters and the associated errors. There were no significant differences among the treatments in either speed of cover development (estimated as days to 50% maximum NDVI, Figure 10) or final cover estimated by maximum NDVI (Figure 11). The size of the error bars suggests that mixtures A – I might be more consistent in development than mixtures J – R.

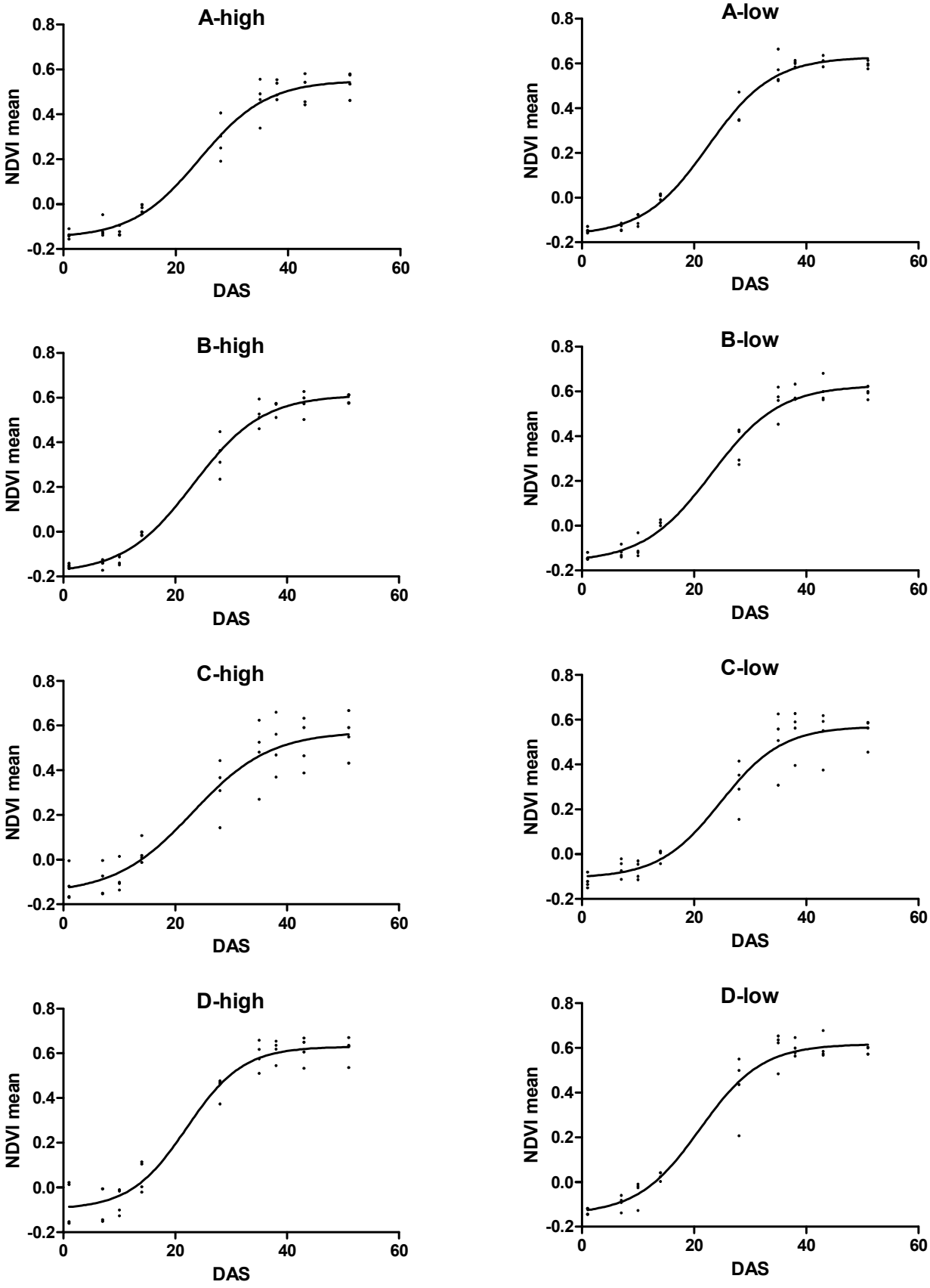

Figure 6. Growth curves fitted to NDVI plot means.

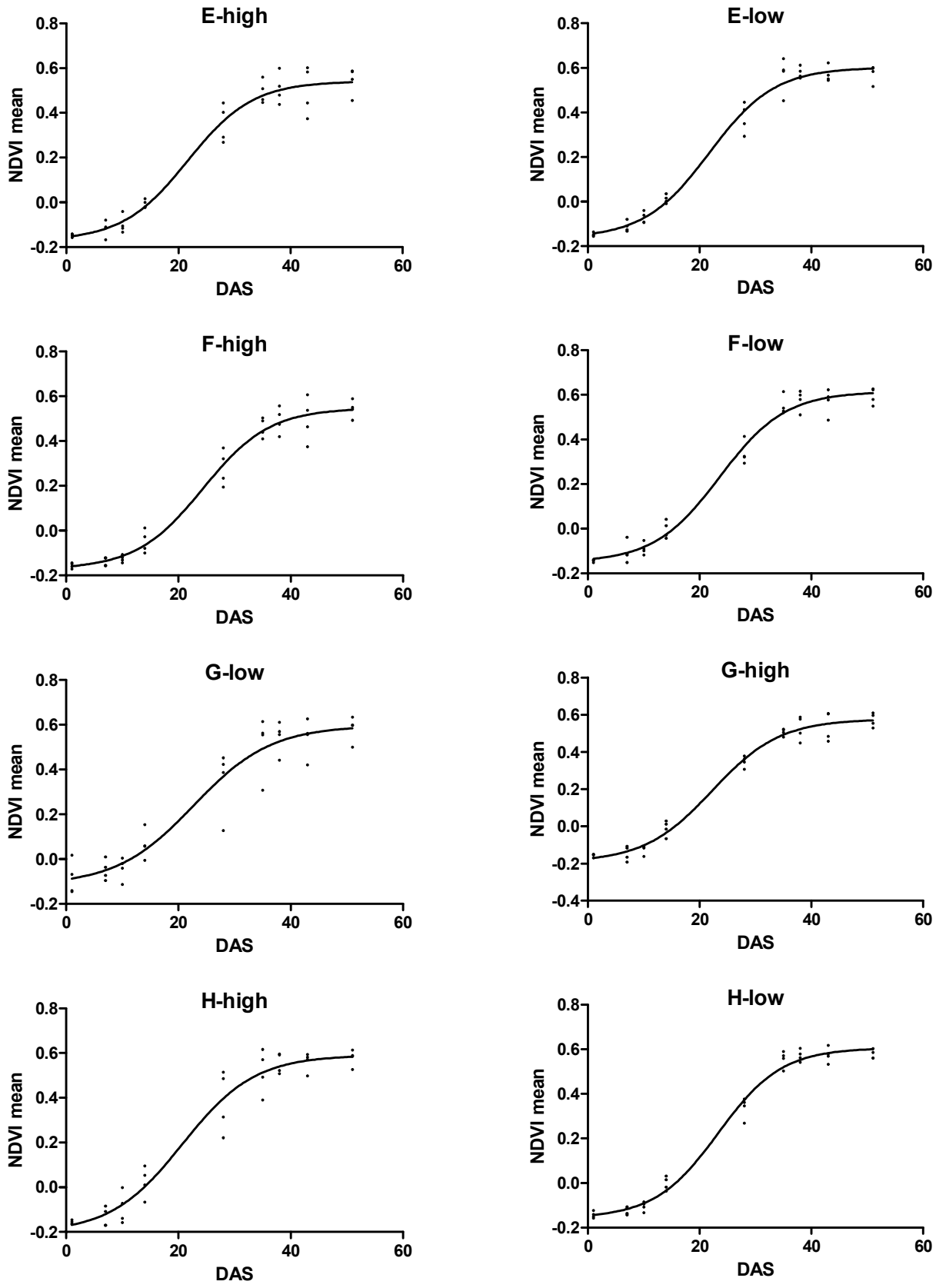

Figure 7. Growth curves fitted to NDVI plot means.

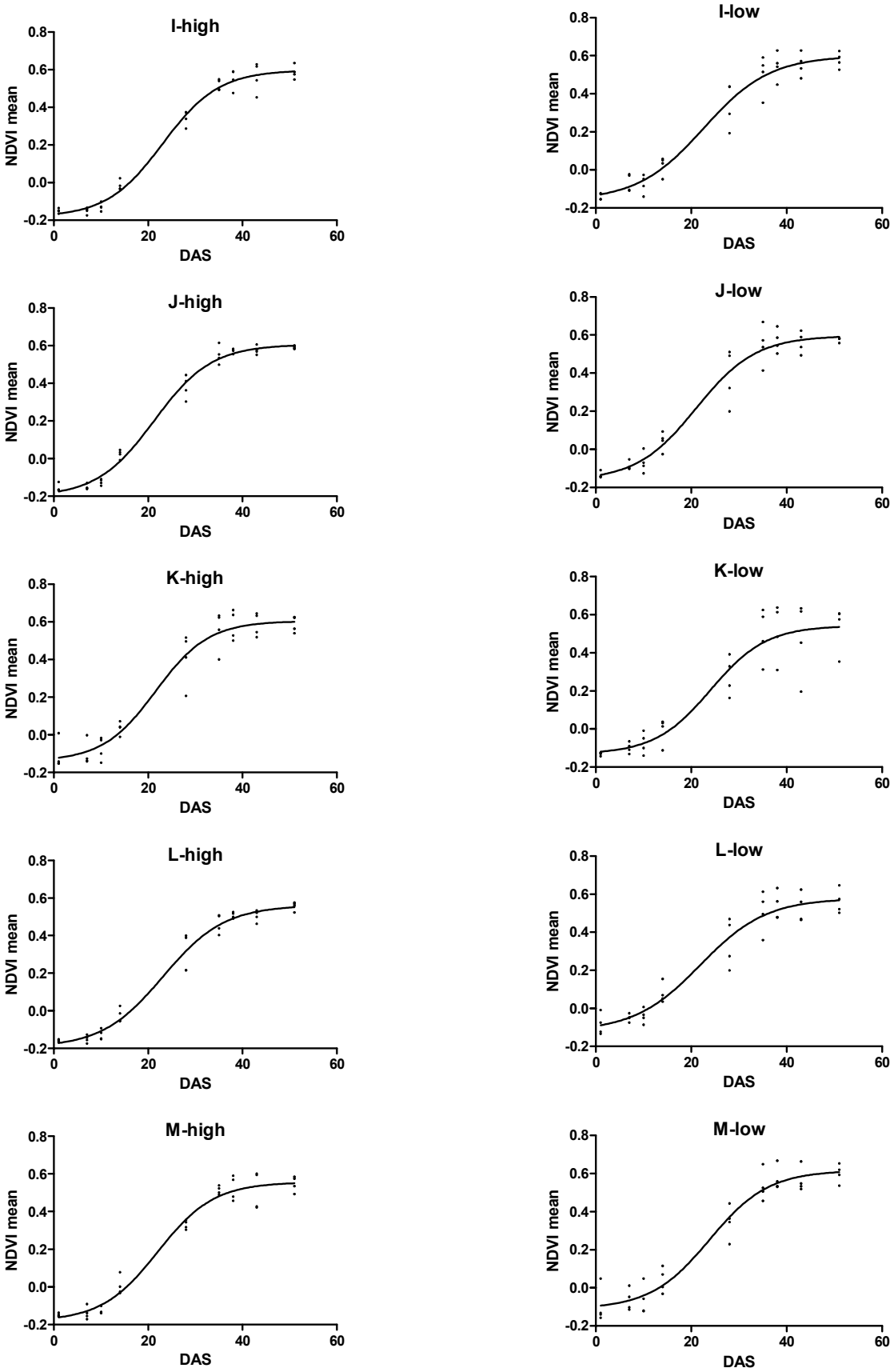

Figure 8. Growth curves fitted to NDVI plot means.

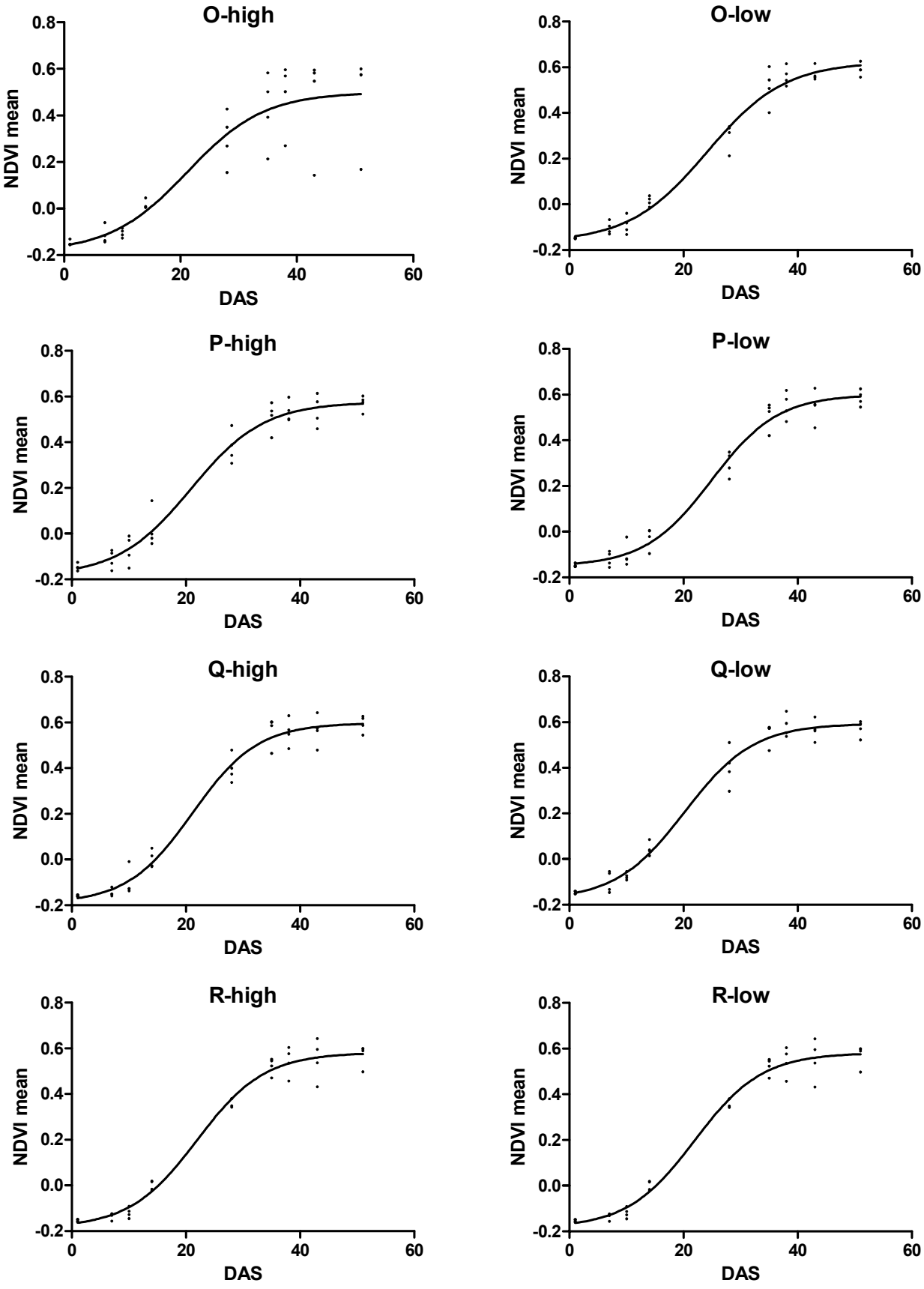

Figure 9. Growth curves fitted to NDVI plot means.

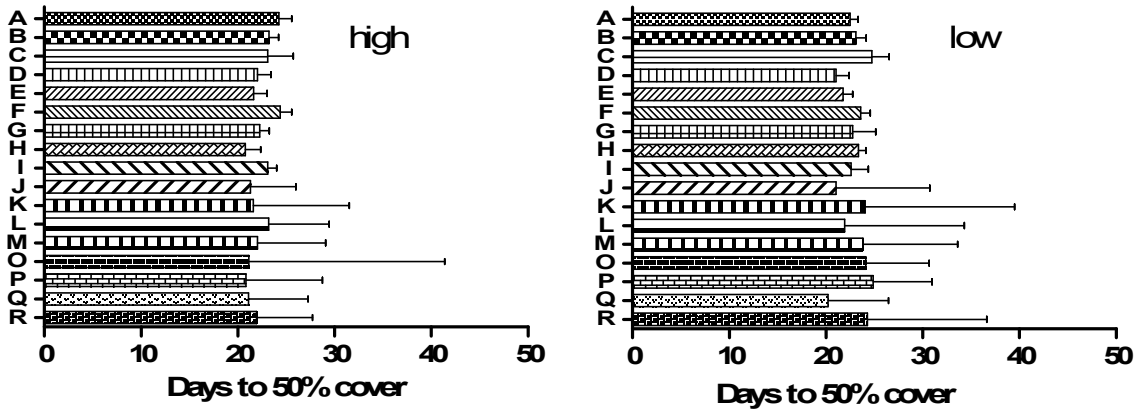

Figure 10. Comparisons of days to 50% of maximum NDVI from ANOVA of fitted logistic growth curves

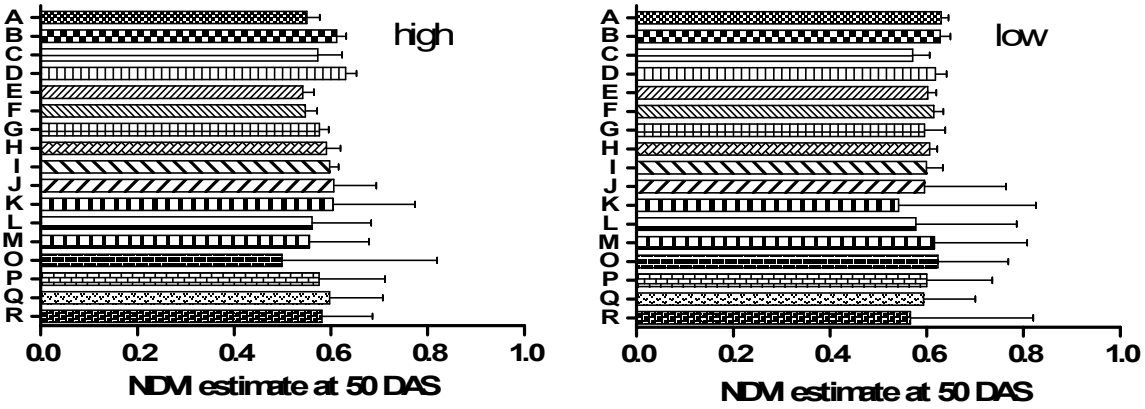

Figure 11. Comparisons of maximum NDVI from ANOVA of fitted logistic growth curves.

DISCUSSION AND CONCLUSIONS

There were some statistically significant differences among the treatments, particularly in the 2 to 4 weeks after seeding period when cover was developing. There was a lot of overlap in performance among the middle mixtures, but mixtures A and H had the best performance in terms of speed and density of cover development and suppression of weed competition. Mixtures F and R were the poorest performers.

Canopy reflectance data did a good job of recording the development of cover, but was not able to differentiate among the treatments as well as visual ratings. This is likely mostly due to the fact that fairly heavy weed infestation, which is integrated into the NDVI readings along with the grass, masked the differences among the grass mixtures.

All the mixtures in the standard maintenance trial responded to the single application of NPK fertilizer and the application of phenoxy herbicide. They were significantly greener and weed free by the end of the season, compared to the low maintenance plots. Because of the cool, wet summer weather, there was no opportunity to observe responses to drought stress.

Winter survival and spring greenup will be observed in spring 2015, and the standard and low maintenance regimes will be continued in 2015 to observe longer term differences among the mixtures.