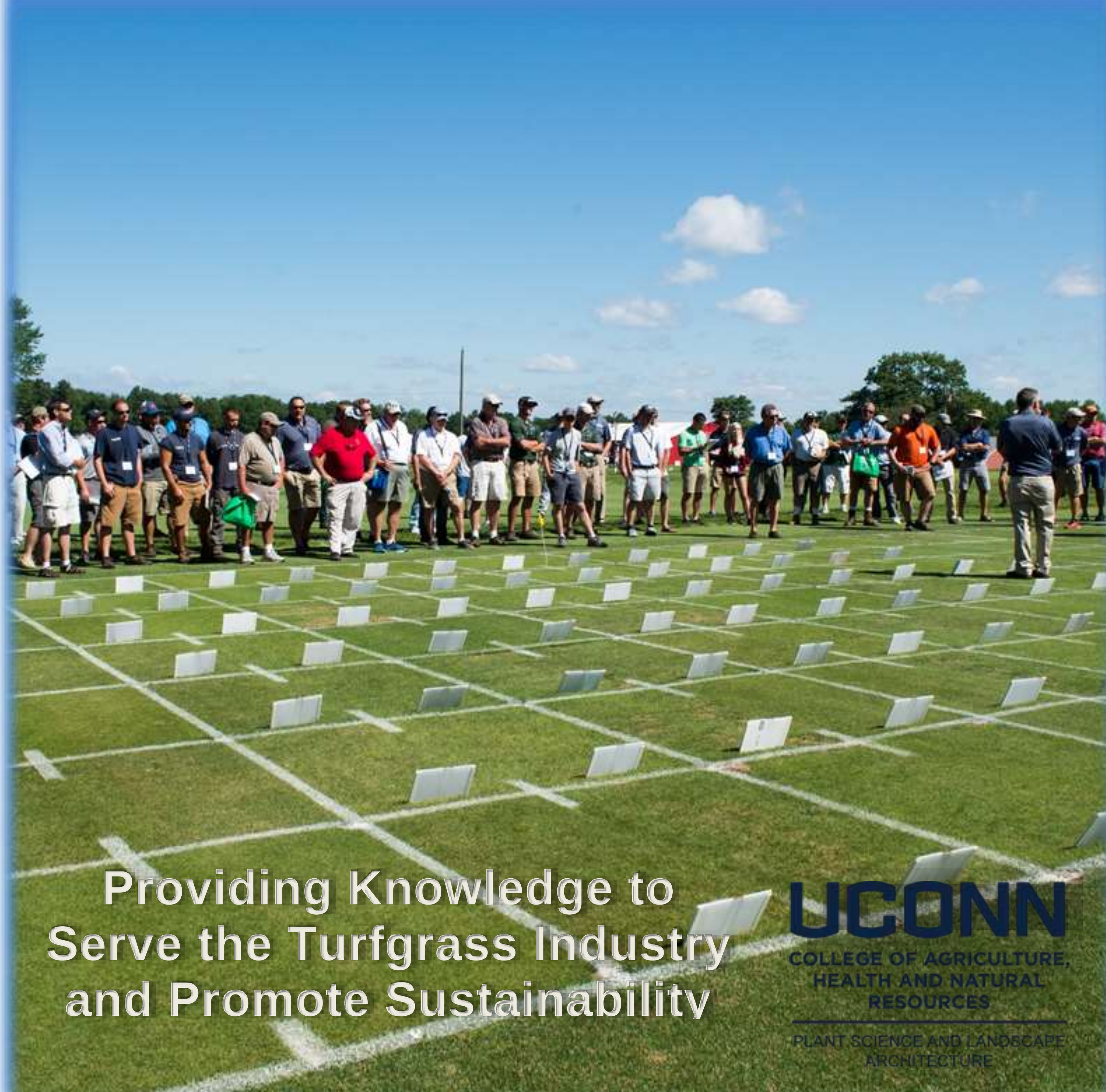
excerpt - a full report can be found at
http://www.turf.uconn.edu/pdf/research/reports/2016%20UConn%20Annual%20Turf%20Research%20Report.pdf

University of Connecticut

College of Agriculture, Health and Natural Resources

2016 Annual Turfgrass Research Report



Providing Knowledge to Serve the Turfgrass Industry and Promote Sustainability

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PLANT SCIENCE AND LANDSCAPE ARCHITECTURE

Cover photo: Turfgrass cultivar evaualtion study being discussed at the 2016 UConn Turfgrass Field Day. (Photo credits: Kim Bova, Kim Bova Photography, www.kimbova.com)

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PLANT SCIENCE AND LANDSCAPE ARCHITECTURE

2016 Annual Turfgrass Research Report Summary

University of Connecticut
College of Agriculture, Health and Natural Resources
Department of Plant Science and Landscape Architecture
Storrs, Connecticut

The University of Connecticut's Annual Turfgrass Research Report is published to provide timely dissemination of current research findings. The purpose of this report is to encourage the exchange of ideas and knowledge between university researchers and members of the turfgrass industry. Research summaries included within this report are designed to provide turfgrass managers, extension specialists, research scientists, and industry personnel with information about current topics related to managing turfgrass.

This report is divided into various sections and includes original research results in turf pathology, athletic field and golf turf maintenance, fertility and nutrient management, and cultivar evaluation and improvement. Additionally, abstracts and citations of scientific publications and presentations published in calendar year 2016 by University of Connecticut turfgrass researchers are included. This information is presented in the hopes of providing current information on relevant research topics for use by members of the turfgrass industry.

Special thanks are given to those individuals, companies, and agencies that provided support to the University of Connecticut's Turfgrass Research, Extension, and Teaching Programs.

Dr. Karl Guillard, Editor

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SOLVITA® SOIL TEST KITS TO CATEGORIZE TURFGRASS SITE RESPONSIVENESS TO NITROGEN FERTILIZATION – 2016 RESULTS

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INTRODUCTION

Currently, there is no routine method of predicting nitrogen fertilization requirements for turfgrass areas. Nitrogen (N) is very transient in the soil, and routine soil tests for turf generally do not include a measure of N. N fertilizer is generally applied at a set rate regardless of soil characteristics. This is not ideal, as too little or too much fertilization can lead to problems related to turfgrass health and environmental pollution. The Solvita® Company (http://solvita.com/soil) offers two simple soil tests kits that could improve our ability to accurately predict N fertilization requirements for turfgrass. The Solvita Labile Amino Nitrogen (SLAN) Test measures the biologically active fraction of N in the soil (also called the 'nitrogen mineralization potential' of the soil); it measures the amount of ammonia gas that is released from the soil during a 24-hour incubation with 10 mls of 2 M NaOH. Presumably, the ammonia released is derived from the active, or labile, fraction of organic matter that contain easily-removable amine groups. The CO_2-Burst Test measures the biologically active fraction of carbon (C) in the soil; it measures the CO_2 released from the soil during a 24-hour incubation with 20 mls of water. Presumably, the CO_2 released is the byproduct of microbial degradation of active organic matter. It is well-understood that the labile C fractions in the soil that the CO_2-Burst Test measures are positively correlated with soil fertility and crop yield (Geng et al. 2014, Hurisso et al. 2016). These Solvita® tests take 1 day and could be done on site without the need to send soil samples to a laboratory for processing. The objective of this research is to determine if these new commercially-available test kits can categorize turf soils as to their responsiveness to N fertilization.

MATERIALS & METHODS

In September of 2007, an organic composted fertilizer (Suståne 5-2-4, all natural fine grade) was incorporated into the 15-cm depth of 1 × 1 m plots at two adjacent sites at 23 different rates ranging from 0 to 400 kg available N ha^{-1} $year^{-1}$. After compost incorporation, one site was seeded to tall fescue (*Festuca arundinacea* cvs. Shortstop II, Dynasty, Crossfire II), and the other was seeded to Kentucky bluegrass (*Poa pratensis* cv. America). The experiments were set out as randomized complete block designs with three replicates. In November of 2008-2010 and 2012-2016, plots were solid-tined aerified and compost was applied again to the same plots using the same rates, and brushed into the aerification holes. Additional treatments in each year include urea in split applications (May, June, Sept., Oct.) at 49, 98, 147, and 196 kg N ha^{-1} $year^{-1}$. The synthetic urea treatments were included so that response of the compost treatments could be matched to that of the synthetic N rate. Urea plots also received 98 kg of K_2O and P_2O_5 at the first urea application in the form of potassium sulfate and triple super phosphate.

On April 25th, 2016, before the first urea application, soil samples were collected from each plot to a depth of 10 cm below the thatch layer, oven-dried, then sieved to pass a 2-mm screen. These samples were analyzed with the Solvita® CO_2-Burst and SLAN test kits. Four grams of soil were used for the SLAN test and 40 grams of soil were used for the CO_2-Burst test. Results are reported as mg kg^{-1} NH_3-N for SLAN and mg kg^{-1} CO_2-C for CO_2-Burst.

At approximately every two weeks during the growing season, turf color quality was measured using Spectrum FieldScout CM 1000 Chlorophyll and TCM 500 NDVI Turf Color meters (Spectrum Technologies, Inc., Aurora, IL).

Grass clippings were harvested monthly from a 0.25-m^2 area in the center of each plot using a Toro push mower with a bagger. The clippings were dried in an oven between 60° and 70°C and weighed. The yearly sum of these monthly clipping weights was determined. Dried grass clippings were ground in a cyclone sample mill (Udy Corporation, Fort Collins, CO) and the ground tissue was analyzed using a LECO TruMac CN determinator (LECO Corporation, Saint Joseph, MI). Total N uptake was determined by multiplying the total N content of the tissue sample by the yearly sum of the harvested grass clippings.

Linear regression models were applied to determine the response of Solvita® CO_2-Burst CO_2-C and SLAN NH_3-N concentrations as a function of organic fertilizer rates, and for mean NDVI readings, mean CM 1000 readings (Chlorophyll Index), sum of the clippings yields, clippings total N concentrations, and the sum of clippings total N uptake as a function of Solvita® CO_2-Burst CO_2-C and SLAN NH_3-N concentrations. The REG procedure of SAS 9.4 (SAS Institute, Cary, NC) was used for the linear models. Logistic curves of binary responses for the probabilities of organic fertilizer responses equaling or exceeding the mean responses obtained from the 150 and 200 kg N ha^{-1} urea treatments (which would typically be the maximum recommended rates of N for lawns in our climate) in relation to Solvita® CO_2-Burst CO_2-C and SLAN NH_3-N concentrations were determined with linear binary logistic models ($a + bx = \{\ln[\pi/(1-\pi)]\}$, where π is the probability of the organic fertilizer response being equal to or exceeding the mean response from the 150 and 200 kg N ha^{-1} urea treatments) using the LOGISTIC procedure of SAS 9.4.

RESULTS

Soil CO_2-C and NH_3-N Concentrations as a Function of Organic Fertilizer Rate

Increasing organic fertilizer rates were generally well correlated with increasing Solvita® CO_2-Burst CO_2-C and SLAN NH_3-N concentrations in a significant ($P < 0.001$) linear response (Figs. 1 and 2, panels A and B). The model fits were better for SLAN NH_3-N than for CO_2-Burst CO_2-C.

Turfgrass Color as a Function of Soil CO_2-C and NH_3-N Concentrations

Turfgrass color, as measured by NDVI and CM 1000 meters, was significantly ($P < 0.001$) and linearly associated with Solvita® CO_2-Burst CO_2-C and SLAN NH_3-N concentrations for Kentucky bluegrass and tall fescue (Figs. 1 and 2, panels C, D, E, and F). The model fits were better for Kentucky bluegrass than for tall fescue.

Turfgrass Clipping Yield as a Function of Soil CO_2-C and NH_3-N Concentrations

Turfgrass clippings yield was significantly ($P < 0.001$) and linearly associated with Solvita® CO_2-Burst CO_2-C and SLAN NH_3-N concentrations for Kentucky bluegrass and tall fescue (Figs. 1 and 2, panels G and H). The model fits were better for Kentucky bluegrass than for tall fescue, and better for SLAN NH_3-N than for CO_2-Burst CO_2-C.

Turfgrass Tissue Total Nitrogen Concentration and Total Nitrogen Uptake as a Function of Soil CO_2-C and NH_3-N Concentrations

Turfgrass tissue total N concentration and total N uptake were significantly ($P < 0.001$) and linearly associated with Solvita® CO_2-Burst CO_2-C and SLAN NH_3-N concentrations for Kentucky bluegrass and tall fescue (Figs. 1 and 2, panels I, J, K, and L). The model fits were better for Kentucky bluegrass than for tall fescue, and better for SLAN NH_3-N than for CO_2-Burst CO_2-C.

Predicting Turfgrass Response as a Function of Soil CO_2-C and NH_3-N Concentrations

Inclusion of the urea treatments provide a convenient way to determine an equivalent response obtained from the organic fertilizer treatments, and to predict turfgrass response based on these equivalent responses. Using binary logistic regression, we were able to calculate the probability of equaling or exceeding the mean response of that obtained from the urea 150 and 200 kg N ha^{-1} $year^{-1}$ rates. These urea rates are typically the maximum recommended seasonal N loading amounts for cool-season turfgrass lawns in our climate; N rates above 200 kg N ha^{-1} $year^{-1}$ generally would not be recommended for established lawns.

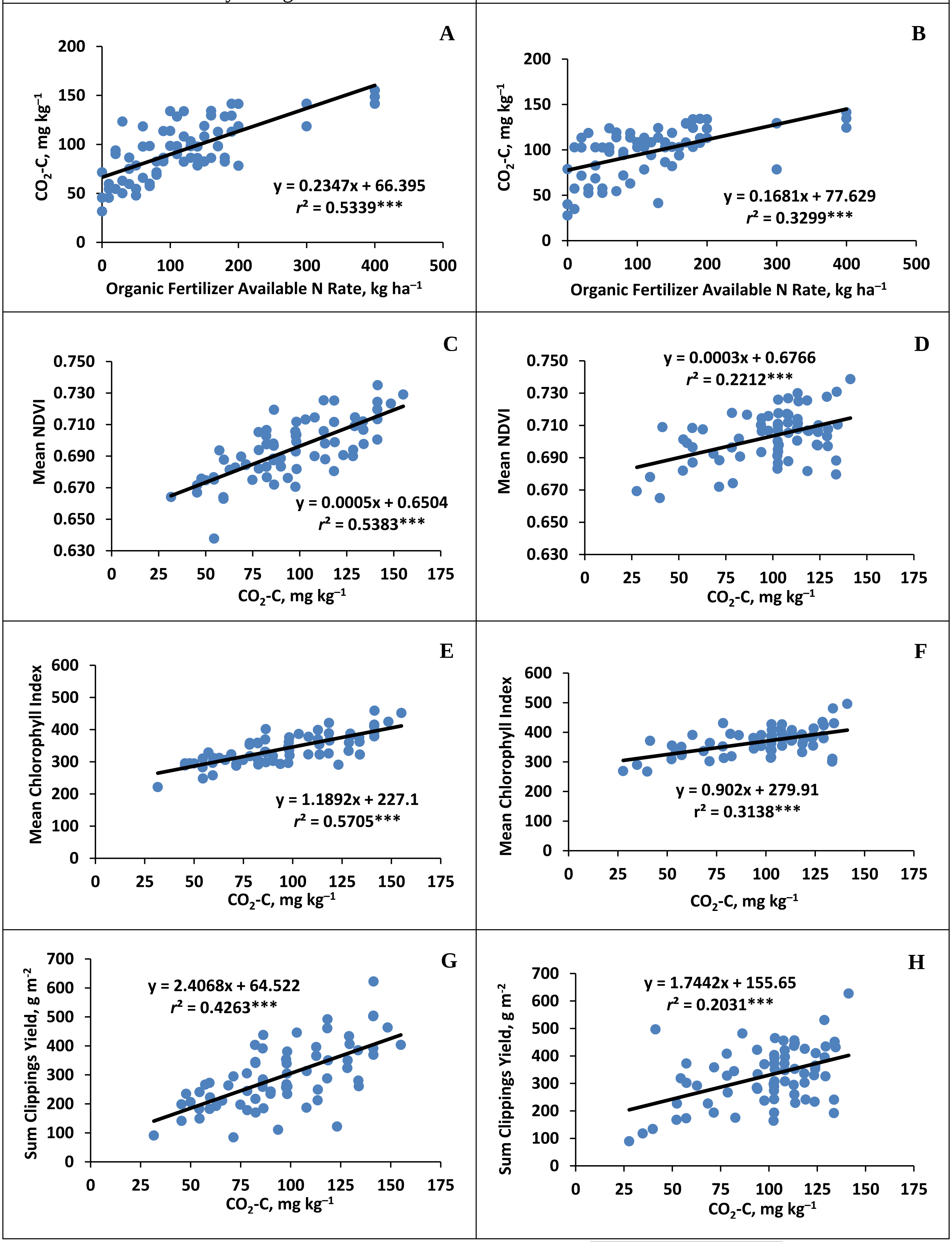
Estimates of the binary logistic regression coefficient parameters and their associated *P*-values are given in Table 1. As a guide for the reader, the Wald *P*-values are used to determine the significance of the slope for the logistic regression (considered significant when $P < 0.05$). The Hosmer-Lemeshow *P*-value indicates the significance of the goodness-of-fit test. The model is considered a good fit for the data when the Hosmer-Lemeshow *P*-value >0.05.

Significant ($P < 0.05$) logistic regression models were found for nearly all variables (NDVI, Chlorophyll Index, clippings yield, total N, and N uptake) for both Kentucky bluegrass and tall fescue (with the exception of tall fescue NDVI versus SLAN NH_3-N concentration) and when both species were combined as a function of soil CO_2-Burst CO_2-C and SLAN NH_3-N concentrations (Table 1). Probability curves indicated that when mean soil CO_2-Burst CO_2-C concentrations were ≤ 93 and ≤ 84 mg kg^{-1}, there was a low probability ($P \leq 0.33$) of response equal to or exceeding that of 150-200 kg N ha^{-1} from urea for Kentucky bluegrass and tall fescue, respectively, across the five measured variables (Fig. 3 panels A and B, and Table 2). When mean CO_2-C concentrations were between 93 to 120 mg kg^{-1} for Kentucky bluegrass and between 84 to 122 mg kg^{-1} for tall fescue, there was a moderate probability ($P > 0.33$ to 0.67) of equaling or exceeding the response obtained from the 150-200 kg N ha^{-1} urea treatments. Mean soil CO_2-C concentrations ≥ 148 mg kg^{-1} and ≥ 162 mg kg^{-1} were associated with a high probability ($P \geq 0.90$) of Kentucky bluegrass and tall fescue responses equaling or exceeding that of 150-200 kg N ha^{-1} from urea, respectively.

Probability curves indicated that when mean SLAN NH_3-N concentrations were ≤ 142 and ≤ 177 mg kg^{-1}, there was a low probability ($P \leq 0.33$) of response equal to or exceeding that of 150-200 kg N ha^{-1} from urea for Kentucky bluegrass and tall fescue, respectively (Fig.3 panels D and E, and Table 2). When mean NH_3-N concentrations were between 142 to 156 mg kg^{-1} for Kentucky bluegrass and between 177 to 213 mg kg^{-1} for tall fescue, there was a moderate probability ($P > 0.33$ to 0.67) of equaling or exceeding the response obtained from the 150-200 kg N ha^{-1} urea treatments. Mean soil SLAN NH_3-N concentrations ≥ 172 mg kg^{-1} and ≥ 250 mg kg^{-1} were associated with a high probability ($P \geq 0.90$) of Kentucky bluegrass and tall fescue responses equal to or exceeding that of 150-200 kg N ha^{-1} from urea, respectively.

When responses from both species were combined, there was a high probability ($P \geq 0.90$) of Kentucky bluegrass and tall fescue responses equaling or exceeding that of the 150-200 kg N ha^{-1} urea treatments when mean soil CO_2-Burst CO_2-C concentrations were ≥ 156 mg kg^{-1} and when mean SLAN NH_3-N concentrations were ≥ 220 mg kg^{-1} (Fig. 3 panels C and F, and Table 2).

Kentucky Bluegrass	Tall Fescue



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Kentucky Bluegrass (continued)	Tall Fescue (continued)

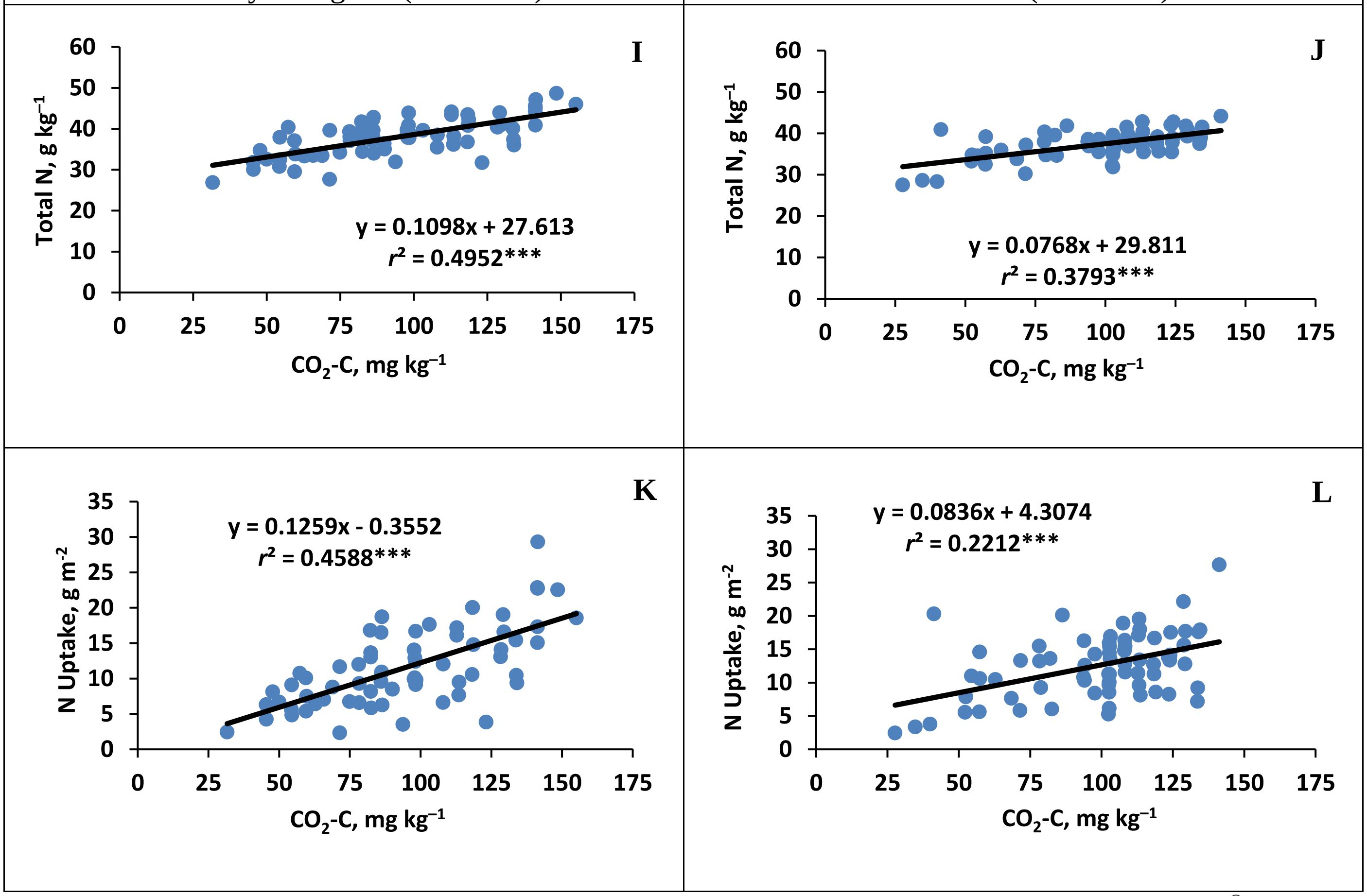

Figure 1. Effects of organic fertilizer rate on of CO_2-C concentrations as measured with the Solvita® CO_2-Burst Test Kit (panels A and B); and relationship between Solvita® CO_2-Burst Test CO_2-C concentrations and NDVI readings (panels C and D), chlorophyll meter readings (panels E and F), clippings yield (panels G and H), clippings total N concentration (panels I and J), and clippings total N uptake (panels K and L) from the organic fertilizer plots. The first column of panels corresponds to Kentucky bluegrass (*Poa pratensis*), and the second column of panels corresponds to tall fescue (*Festuca arundinacea*). Significance of the positive linear response: *** ($P < 0.001$).

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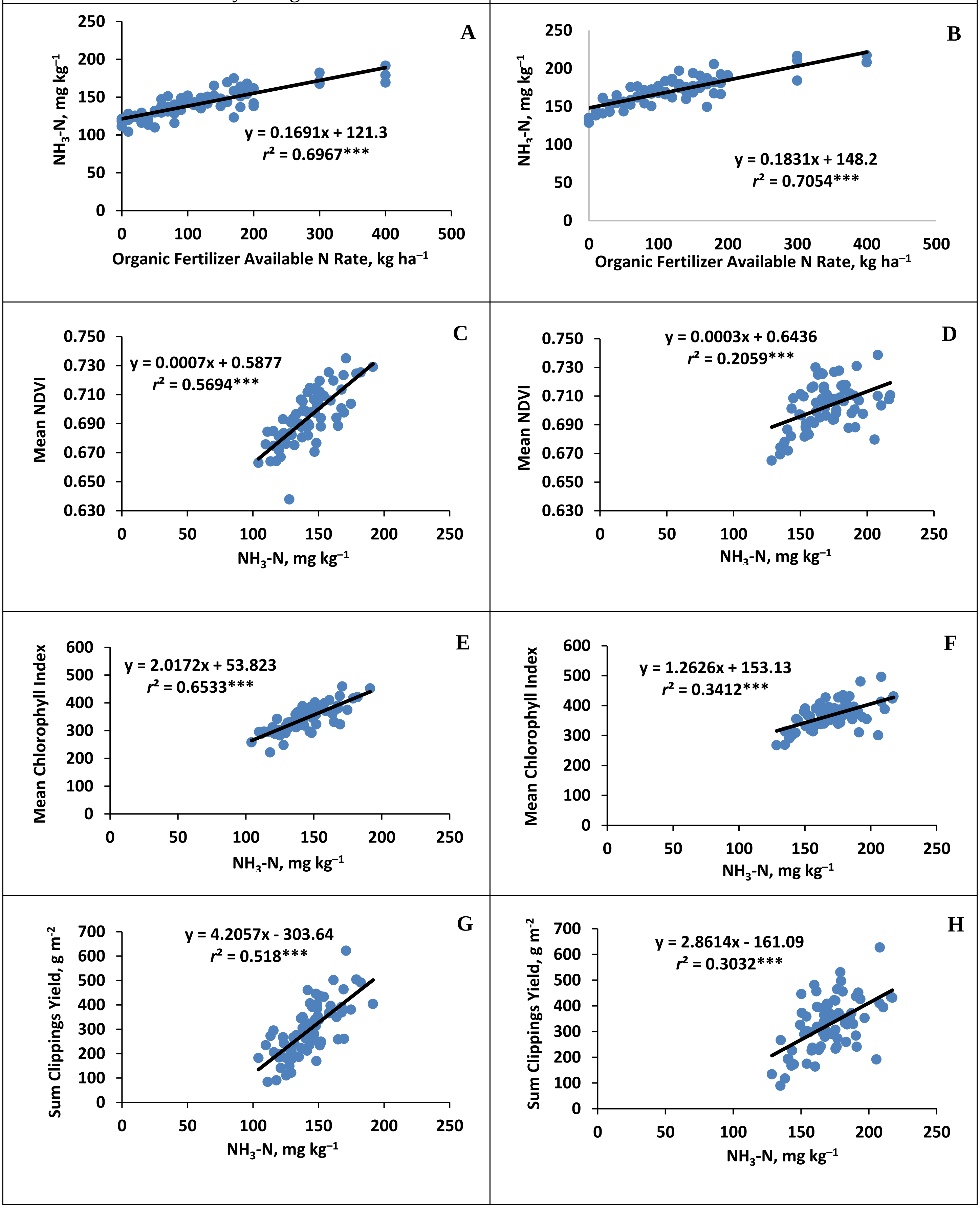
Kentucky Bluegrass	Tall Fescue



Kentucky Bluegrass (continued)	Tall Fescue (continued)

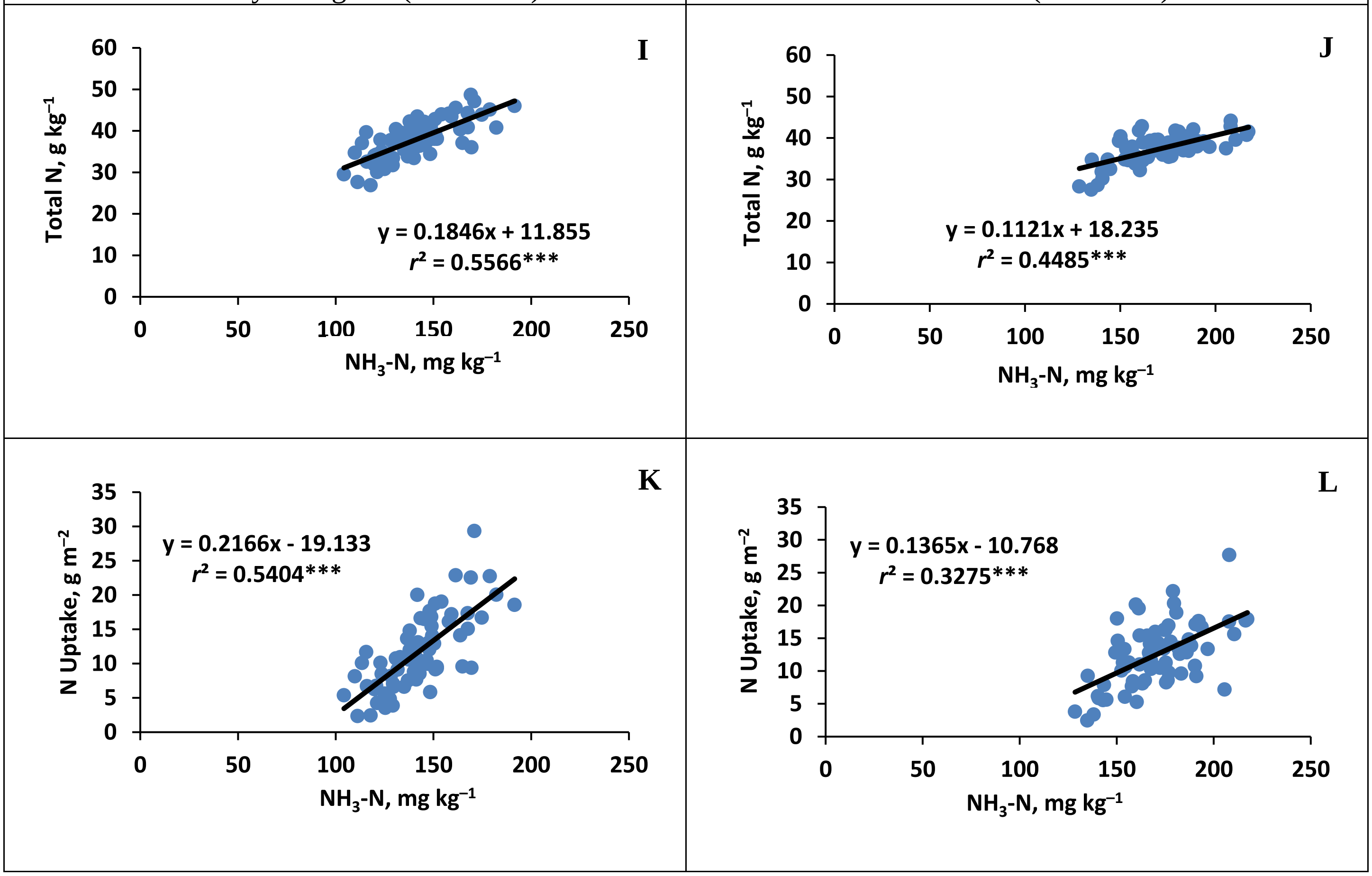


Figure 2. Effects of organic fertilizer rate on NH_3-N concentrations as measured with the SLAN Test Kit (panels A and B); and relationship between SLAN NH_3-N concentrations and NDVI readings (panels C and D), chlorophyll meter readings (panels E and F), clippings yield (panels G and H), clippings total N concentration (panels I and J), and clippings total N uptake (panels K and L) from the organic fertilizer plots. The first column of panels corresponds to Kentucky bluegrass (*Poa pratensis*), and the second column of panels corresponds to tall fescue (*Festuca arundinacea*). Significance of coefficient of for the positive linear response: *** ($P < 0.001$).

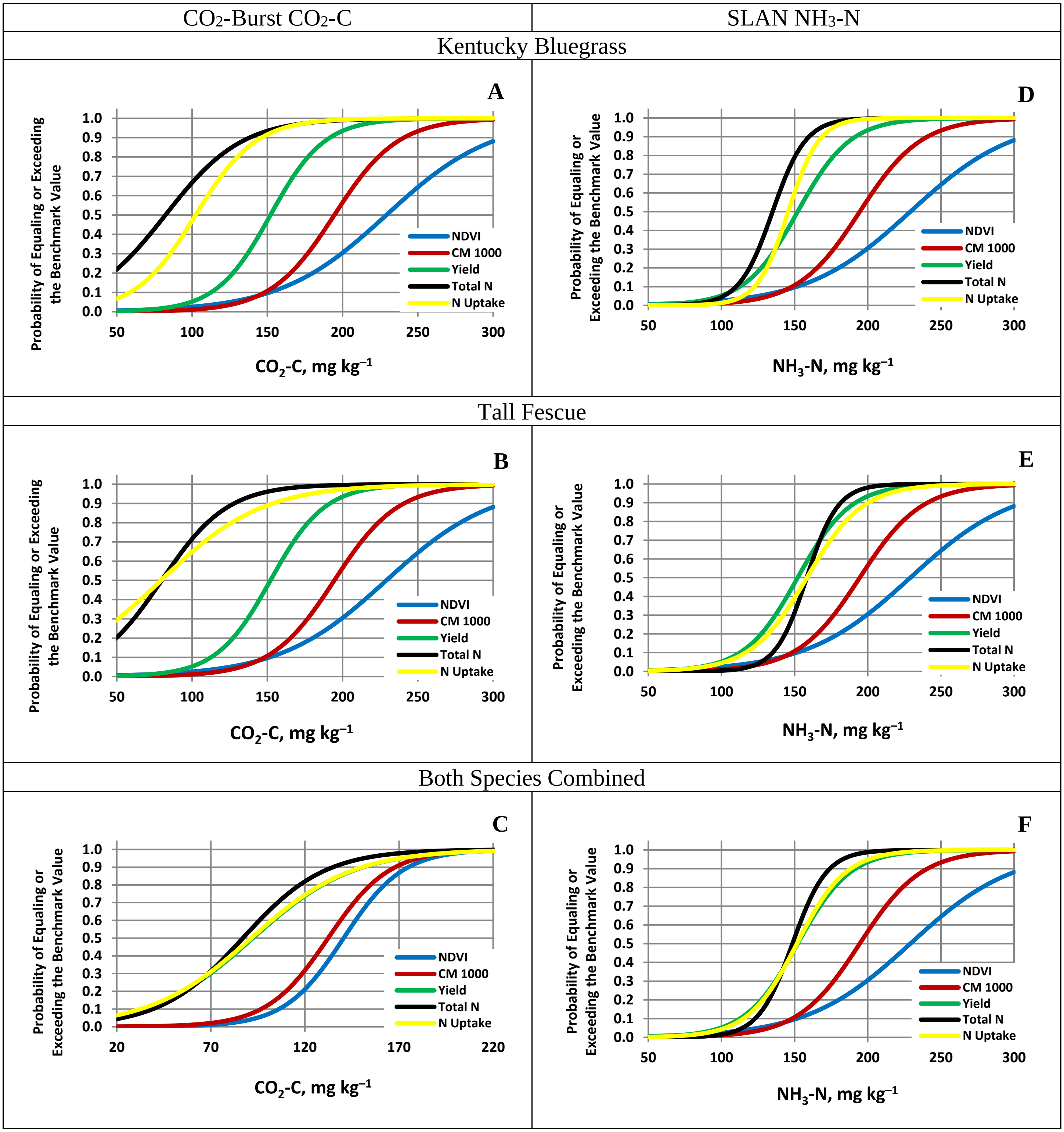


Figure 3. Probability curves of equaling or exceeding the NDVI, CM1000 (Chlorophyll Index), clippings yield, total N, and N uptake values of that obtained from the mean response of urea at the 150 and 200 kg N ha^{-1} rates in relation to Solvita® Soil CO_2-Burst CO_2-C concentrations (panels A, B, and C) and SLAN NH_3-N concentrations (panels D, E, and F) for the 2014 growing season. Mean urea response at the 150 and 200 kg N ha^{-1} rates for NDVI, CM1000, sum of the monthly clippings yield (g m^{-2}), total N (g N kg^{-1}), and N uptake (g m^{-2}) values were 0.711, 371, 285.4, 37.5, and 11.0 for Kentucky bluegrass, respectively; 0.723, 406, 299.6, 36.6, and 11.0 for tall fescue, respectively; and 0.717, 389, 292.5, 37.0, and 11.0 across both species combined, respectively.

Table 1. Logistic regression coefficients for binary response of NDVI, Chlorophyll Index (CM1000), clippings yield (Yield), Total N concentration, and N uptake (NUP) values being equal to or exceeding the mean response for the urea 150 and 200 kg ha^{-1} treatments for Kentucky bluegrass and tall fescue lawns in relation to Solvita® CO_2-Burst CO_2-C and SLAN NH_3-N concentrations for the 2016 growing season.

	CO_2-Burst Test									
	Kentucky Bluegrass					Tall Fescue				
Variable	Intercept	Slope	Wald *p*-value	Max. rescaled r^2	Hosmer – Lemeshow *p*-value	Intercept	Slope	Wald *p*-value	Max. rescaled r^2	Hosmer – Lemeshow *p*-value
NDVI	-8.024	0.0628	0.0002	0.4421	0.8208	-9.012	0.0633	0.0230	0.2263	0.9064
CM1000	-8.493	0.0702	<0.0001	0.5131	0.7056	-7.173	0.0521	0.0138	0.2142	0.2222
Yield	-5.381	0.0536	<0.0001	0.4270	0.6044	–1.810	0.0232	0.0185	0.1146	0.4967
Total N	-3.235	0.0393	0.0004	0.2890	0.1517	-3.649	0.0457	0.0002	0.3265	0.5542
NUP	-5.141	0.0502	<0.0001	0.3982	0.5118	-2.351	0.0296	0.0046	0.1721	0.6462

	SLAN Test									
	Kentucky Bluegrass					Tall Fescue				
Variable	Intercept	Slope	Wald *p*-value	Max. rescaled r^2	Hosmer – Lemeshow *p*-value	Intercept	Slope	Wald *p*-value	Max. rescaled r^2	Hosmer – Lemeshow *p*-value
NDVI	–14.779	0.0909	0.0003	0.4160	0.8042	-4.888	0.0165	0.3725	0.0224	0.1715
CM1000	–19.326	0.1235	0.0001	0.5510	0.8361	–13.002	0.0644	0.0017	0.2885	0.3625
Yield	–13.295	0.0919	<0.0001	0.4383	0.3924	-8.297	0.0519	0.0016	0.2350	0.4532
Total N	–11.886	0.0881	0.0001	0.4082	0.3264	–14.894	0.0941	0.0001	0.4503	0.0157
NUP	–13.821	0.0949	<0.0001	0.4518	0.3013	-8.300	0.0524	0.0016	0.2359	0.3066

	CO_2-Burst Test					SLAN Test				
	Kentucky Bluegrass and Tall Fescue Combined					Kentucky Bluegrass and Tall Fescue Combined				
Variable	Intercept	Slope	Wald *p*-value	Max. rescaled r^2	Hosmer – Lemeshow *p*-value	Intercept	Slope	Wald *p*-value	Max. rescaled r^2	Hosmer – Lemeshow *p*-value
NDVI	-8.982	0.0639	<0.0001	0.3168	0.8080	-6.484	0.0283	0.0100	0.0931	0.4696
CM1000	-8.164	0.0617	<0.0001	0.3452	0.3873	-9.240	0.0475	<0.0001	0.2434	0.8063
Yield	-3.462	0.0375	<0.0001	0.2602	0.4214	-8.456	0.0556	<0.0001	0.3374	0.1599
Total N	-3.993	0.0459	<0.0001	0.3402	0.5707	–12.761	0.0859	<0.0001	0.5118	0.6577
NUP	-3.410	0.0373	<0.0001	0.2590	0.5354	-9.083	0.0599	<0.0001	0.3671	0.1083

Table 2. Concentrations of Solvita® CO_2-Burst CO_2-C and SLAN NH_3-N at selected probabilities of equaling or exceeding the response of 150-200 kg N ha^{-1} using urea for NDVI, Chlorophyll Index (CM1000), clippings yield (Yield), clippings Total N concentration, and N uptake (NUP) for 2016.

Kentucky Bluegrass

	CO_2-Burst CO_2-C Concentrations, mg kg^{-1}						SLAN NH_3-N Concentrations, mg kg^{-1}					
P	NDVI	CM1000	Yield	Total N	NUP	Mean	NDVI	CM1000	Yield	Total N	NUP	Mean
0.33	116	111	87	64	88	93	155	151	137	127	138	142
0.67	139	131	114	100	117	120	170	162	152	143	153	156
0.90	163	152	141	138	146	148	187	174	169	160	169	172

Tall Fescue

	CO_2-Burst CO_2-C Concentrations, mg kg^{-1}						SLAN NH_3-N Concentrations, mg kg^{-1}					
P	NDVI	CM1000	Yield	Total N	NUP	Mean	NDVI	CM1000	Yield	Total N	NUP	Mean
0.33	131	124	47	64	55	84	253	191	146	151	145	177
0.67	154	151	109	95	103	122	339	213	174	166	172	213
0.90	177	180	173	128	154	162	429	236	202	182	200	250

Kentucky Bluegrass and Tall Fescue Combined

	CO_2-Burst CO_2-C Concentrations, mg kg^{-1}						SLAN NH_3-N Concentrations, mg kg^{-1}					
P	NDVI	CM1000	Yield	Total N	NUP	Mean	NDVI	CM1000	Yield	Total N	NUP	Mean
0.33	129	121	73	72	72	93	204	180	139	140	140	161
0.67	152	144	111	102	110	124	254	209	165	157	163	190
0.90	175	168	151	135	150	156	307	241	192	174	188	220

SUMMARY AND CONCLUSIONS

The third-year results of this study suggest that the Solvita® CO_2-Burst and SLAN Test kits show promise in estimating cool-season turfgrass lawn response as a function of CO_2-C and NH_3-N concentrations in soil samples collected in the spring prior to fertilization. Better fits of the data were obtained with the SLAN test kit compared to the results of the CO_2-Burst test kit, but both did reasonably well.

One objective of the research is to establish response categories (Low, Moderate, or High) that will guide N fertilization of turfgrass lawns based on concentrations of CO_2-Burst CO_2-C and SLAN NH_3-N concentrations. Concentrations presented in Table 2 can be used as starting benchmark values for these categories for equaling or exceeding the response of 150-200 kg N ha^{-1} urea treatments. When concentrations have $P \leq 0.33$, then the category would be considered 'Low'; when concentrations have $P > 0.33$ to 0.67, then the category would be 'Moderate'; when concentrations have $P > 0.67$, then the category would be 'High'; when concentrations have $P > 0.90$, then the category would be 'Very High'.

Using Kentucky bluegrass NDVI response for turfgrass color as an example, it would be unlikely that much N fertilizer would be needed when soil CO_2-C concentrations are ≥ 139 mg kg^{-1}, or when SLAN NH_3-N concentrations are ≥ 170 mg kg^{-1} ($P \geq 0.67$, Table 2). When CO_2-C and NH_3-N concentrations exceed 163 and 187 mg kg^{-1}, respectively, there would be only a 10% chance or less that the Kentucky bluegrass NDVI would increase in a response equivalent to 150-200 kg N ha^{-1} to added N fertilization. In these cases, supplemental N should be withheld and applied only in special cases where turf response is less than optimum after growth is monitored before applying N. Application of supplemental N in areas when CO_2-Burst and SLAN test kits read high increases the likelihood of N losses from the system and more problems with insect and disease pests.

The 2016 CO_2-Burst SLAN responses are very similar to the trends obtained in previous research on these same plots when predicting turfgrass response to the soil permanganate-oxidizable carbon (POXC) and Illinois Soil N Test (ISNT)-N concentrations obtained from a spring soil sample across 5 years (2008-2012; Geng et al., 2014). SLAN NH_3-N concentrations obtained from archived soil samples from the Geng et al., 2014 study are highly correlated ($P < 0.01$) with the respective ISNT-N concentrations (data not shown). This suggests that the Solvita® SLAN test may have similar predictive power in guiding N fertilization as does the ISNT.

As more data are collected, different delineation ranges may come forth. However, we are encouraged with the results across three years, and think that the Solvita® could provide an objective guide for N fertilization of cool-season turfgrass lawns.

ACKNOWLEDGEMENTS

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