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College of Agriculture, Health and Natural Resources

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UConn Turfgrass Science Team at the start of the 2014 Turfgrass Field Day

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PLANT SCIENCE AND LANDSCAPE ARCHITECTURE

Cover photo: Members of the UConn Turfgrass Science Team at the start of the 4th Biennial UConn Turfgrass Field Day, July 15, 2014. From left to right: Kevin Miele, G. Scott Vose, Steven Rackliffe, Victoria Wallace (front), Jason Henderson (back), Karl Guillard, John Inguagiato, and Stephen Olsen. (Photo credits: Kim Bova, Kim Bova Photography, www.kimbova.com)

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SOLVITA® SOIL TEST KITS TO CATEGORIZE TURFGRASS SITE RESPONSIVENESS TO NITROGEN FERTILIZATION – 2014 RESULTS

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INTRODUCTION

The ability to predict the nitrogen mineralization potential of any turfgrass site would be a valuable tool in nutrient management. Guiding nitrogen fertilization based on an objective soil test should help to avoid too little or too much nitrogen applied to turf that often occurs when using subjective criteria to determine how much nitrogen a turf needs. Insufficient or excessive nitrogen applications can lead to poor aesthetic and functional turf performance, increases in certain diseases and insects, and water quality problems when excess N is applied. The Solvita® company offers two field test kits that have been developed to measure the biologically-active C and N fractions in soil organic matter: the Soil CO_2-Burst and Soil Labile Amino Nitrogen (SLAN) Test Kits, respectively (http://solvita.com/soil). These kits are designed for on-site use, without the need to send soil samples to a laboratory. There is some preliminary evaluation of these kits for field crops that looks promising as guides to N fertilization, but currently there has been no evaluation of these kits on turfgrass soils. The Soil CO_2-Burst Test kit measures the amount of CO_2 that is presumably released from microbial respiration and degradation of the labile-C fraction of the soil organic matter. Soil microbial respiration is positively correlated to soil fertility and crop yield response. It should also function as the same indicator in turf soils with respect to turf growth and quality. The SLAN Test kit presumably measures the labile amino-N fraction of the soil organic matter which should indicate the mineralization potential of the soil. The objective of this research is to determine if these new commercially-available field 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 392 kg available N/ha/year. 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, 2009, 2010, 2012, and 2013, 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/year. 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. In early May of 2014 before urea application, soil samples were collected from each plot to a depth of 10-cm below the thatch layer, air-dried, then sieved to pass a 20-mesh screen. These samples were analyzed with the Solvita® Soil CO_2-Burst and Soil Labile Amino Nitrogen (SLAN) Test Kits. At approximately every two weeks during the growing season, turf color quality was measured using Spectrum CM1000 Chlorophyll and TCM500 NDVI Turf Color meters. Typically, greener turf is related to higher reading values with these meters. Turf growth (yield of clippings) was collected monthly.

Linear regression models were applied to determine the response of Solvita® CO_2-Burst CO_2-C and SLAN NH_3-N as a function of organic fertilizer rates. Linear and quadratic regression models were used to determine the relationship of mean NDVI readings, mean CM1000 readings and the sum of the clippings yields as a function of Solvita® CO_2-Burst CO_2-C and SLAN NH_3-N. The REG procedure of SAS 9.3 (SAS Institute, Cary, NC) was used for the linear and quadratic regression analyses. Logistic curves of binary responses for the probabilities of organic fertilizer plot NDVI, CM1000, and clippings yield values being less than the mean responses obtain 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 9.3.

RESULTS

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

Increasing organic fertilizer rates were generally correlated with increasing Solvita® CO_2-Burst CO_2-C concentrations in a significant ($p<0.05$) but weak linear response (Fig. 1, panels A and B), and with SLAN NH_3-N concentrations in a significant ($p<0.05$) and moderately strong linear response (Fig. 2, panels A and B). 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 Color as a Function of Soil CO_2-C and NH_3-N Concentrations

Turfgrass color, as measured by NDVI and CM1000 meters, was significantly ($p<0.05$) and linearly associated with Solvita® CO_2-Burst CO_2-C concentrations (Fig. 1, panels C, D, E, and F), and quadratically ($p<0.001$) with SLAN NH_3-N concentrations (Fig. 2, panels C, D, E, and F). 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 Clipping Yield as a Function of Soil CO_2-C and NH_3-N Concentrations

Turfgrass clippings yield was significantly ($p<0.05$) and linearly associated with Solvita® CO_2-Burst CO_2-C concentrations for Kentucky bluegrass (Fig. 1, panel G; although the association was weak), but not for tall fescue ($p>0.05$) (Fig. 1, panel H). Turfgrass clippings yield was significantly ($p<0.001$) and quadratically associated with Solvita® SLAN NH_3-N concentrations (Fig. 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.

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} yr^{-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} yr^{-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.

For the Soil CO_2-Burst CO_2-C concentrations, significant ($p<0.05$) logistic regression were found only for Kentucky bluegrass NDVI and CM1000, for tall fescue clippings yield, or for NDVI when species were combined (Table 1). Of the significant models, the fits were weak and predictive power was relatively poor, most likely due to the large amount of variation present in the Soil CO_2-Burst CO_2-C concentration data (see Fig. 1). At best, the predictive model could only estimate that there was ≤ 90% chance that turfgrass response of the organic fertilizer plots would equal or exceed the mean response from the urea 150, and 200 kg N ha^{-1} yr^{-1} rates at the very highest concentrations of CO_2-C (Fig. 3 panels A, B, and C). The predictive power or logistic model fits were not improved by combining the species (Fig. 3 panel C).

For the SLAN NH_3-N concentrations, significant ($p<0.05$) logistic regression were found for all NDVI, CM1000, and clippings yield models for Kentucky bluegrass, tall fescue, and when species were combined (Table 1). Predictive power for SLAN NH_3-N concentrations was much better than the Soil CO_2-Burst CO_2-C concentrations. Best model fits and predictive power were observed with Kentucky bluegrass NDIV and CM1000 (Table 1). The predictive models suggested that once SLAN NH_3-N concentrations ranged between 150 and 200 mg kg^{-1}, there was a 70% to near 100% probability of equaling or exceeding the mean response from the urea 150, and 200 kg N ha^{-1} yr^{-1} rates (Fig. 4 panels D, E, and F). The predictive power or logistic model fits were not improved by combining the species (Fig. 4 panel F).

Table 1. Logistic regression coefficients for binary response of NDVI, CM1000, and clippings yield 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® Soil CO_2-Burst CO_2-C and SLAN NH_3-N concentrations for the 2014 growing season.

	CO_2-Burst Test CO_2-C Concentrations									
	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	-2.7310	0.0355	0.0239	0.1095	0.0324	-0.6231	0.0072	0.5213	0.0080	0.3691
CM1000	-2.7091	0.0376	0.0188	0.1204	0.1428	-0.0189	0.0038	0.7363	0.0022	0.9478
Yield	-0.2444	0.0184	0.2558	0.0286	0.2875	-0.9513	0.0257	0.0492	0.0831	0.7929

	SLAN NH_3-N Concentrations									
	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	-16.895	0.1185	0.0002	0.4731	0.5863	-8.9001	0.0649	0.0026	0.2284	0.7748
CM1000	-14.771	0.1056	0.0002	0.4255	0.3210	-8.3714	0.0640	0.0032	0.2154	0.6822
Yield	-9.639	0.0772	0.0024	0.2719	0.5334	-7.9959	0.0669	0.0054	0.2010	0.1520

	CO_2-Burst Test CO_2-C Concentrations					SLAN NH_3-N Concentrations				
	Kentucky bluegrass + Tall fescue combined					Kentucky bluegrass + 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	-1.1899	0.0191	0.0287	0.0477	0.0105	-8.0855	0.0601	<.0001	0.2346	0.8075
CM1000	-0.5129	0.0094	0.2660	0.0121	0.1410	-4.9959	0.1056	0.0371	0.1253	0.3661
Yield	-0.0786	0.0170	0.0872	0.0322	0.4214	-7.2796	0.0622	0.0002	0.1992	0.8983

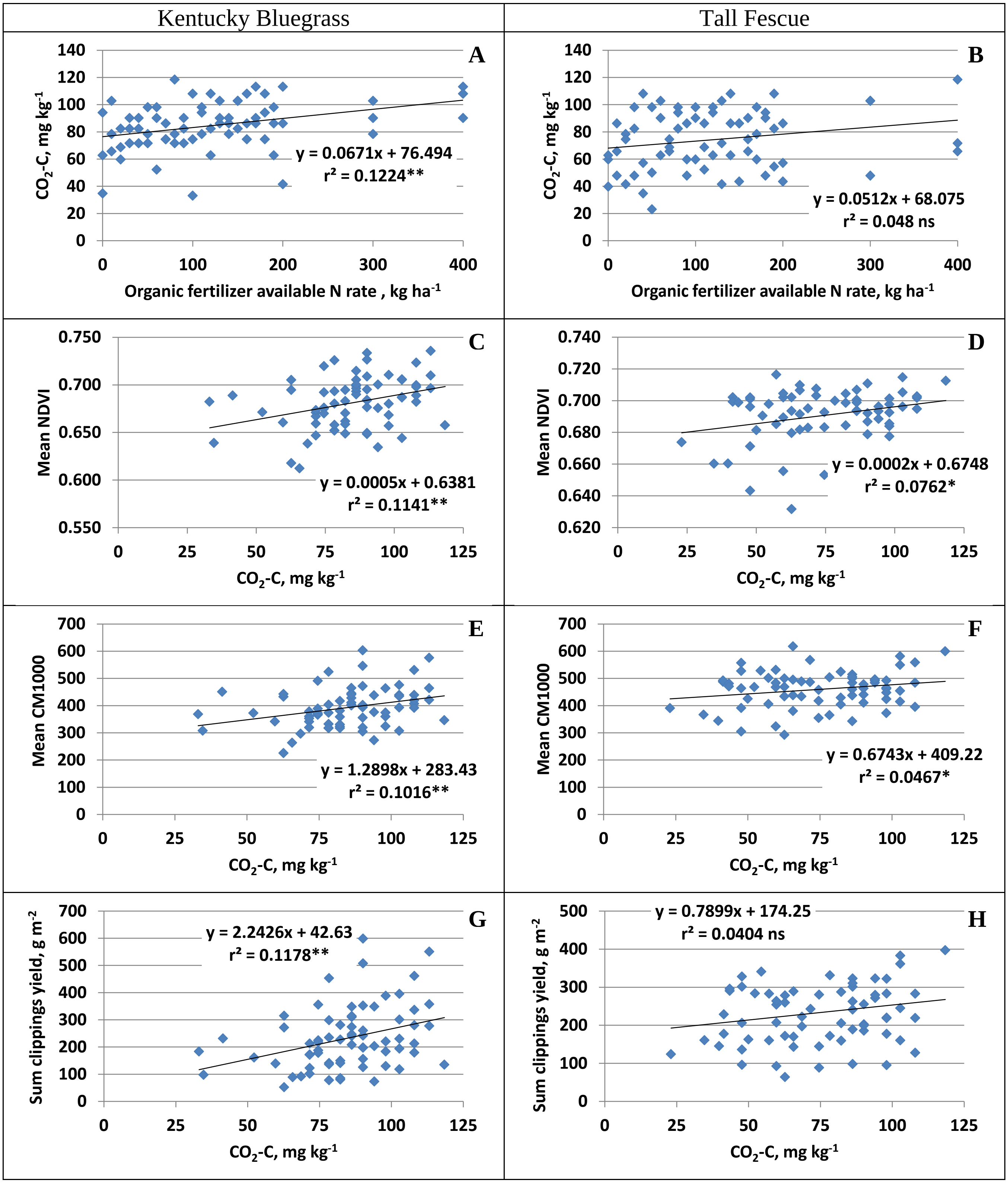

Fig. 1. Effects of organic fertilizer rate (panels A and B) on the production of CO_2-C as measured with the Solvita® CO_2-Burst Test Kit, and relationship between Solvita® CO_2-Burst Test CO_2-C and: NDVI readings from organic fertilizer plots (panels C and D); CM1000 readings from organic fertilizer plots (panels E and F); and clippings yield from organic fertilizer plots (panels G and H). The first column of panels correspond to Kentucky bluegrass (*Poa pratensis*), and the second column of panels correspond to tall fescue (*Festuca arundinacea*). Significance of coefficient of determination (r^2) for the linear response: * (p<0.05), ** (p<0.01), and ns not significant (p>0.05).

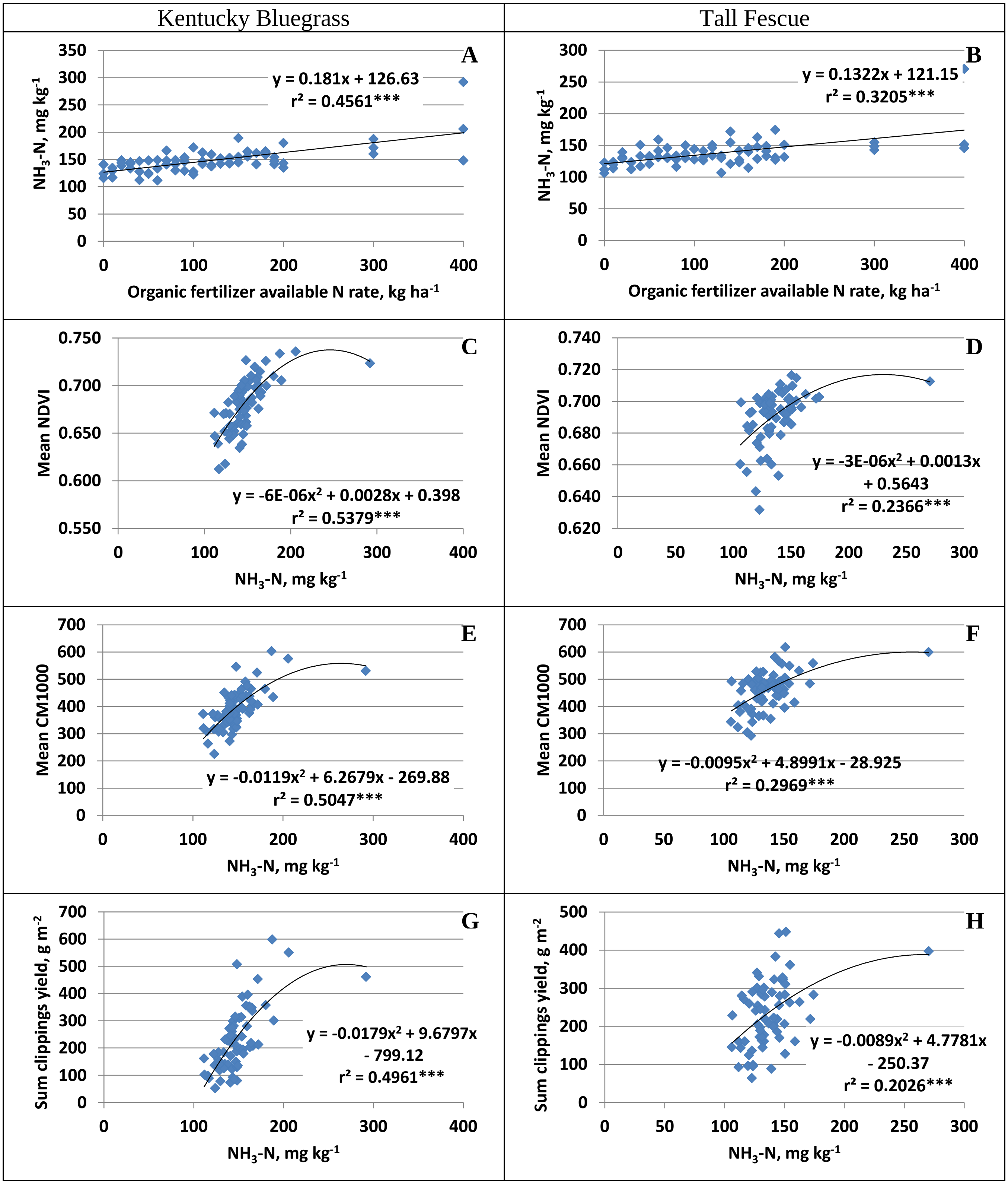

Fig. 2. Effects of organic fertilizer rate (panels A and B) on the production of NH_3-N as measured with the Solvita® Soil Labile Amino Nitrogen (SLAN) Test Kit, and relationship between Solvita® SLAN Test NH_3-N and: NDVI readings from organic fertilizer plots (panels C and D); CM1000 readings from organic fertilizer plots (panels E and F); and clippings yield from organic fertilizer plots (panels G and H). The first column of panels correspond to Kentucky bluegrass (*Poa pratensis*), and the second column of panels correspond to tall fescue (*Festuca arundinacea*). Significance of coefficient of determination (r^2) for the linear and quadratic response: *** (p<0.001).

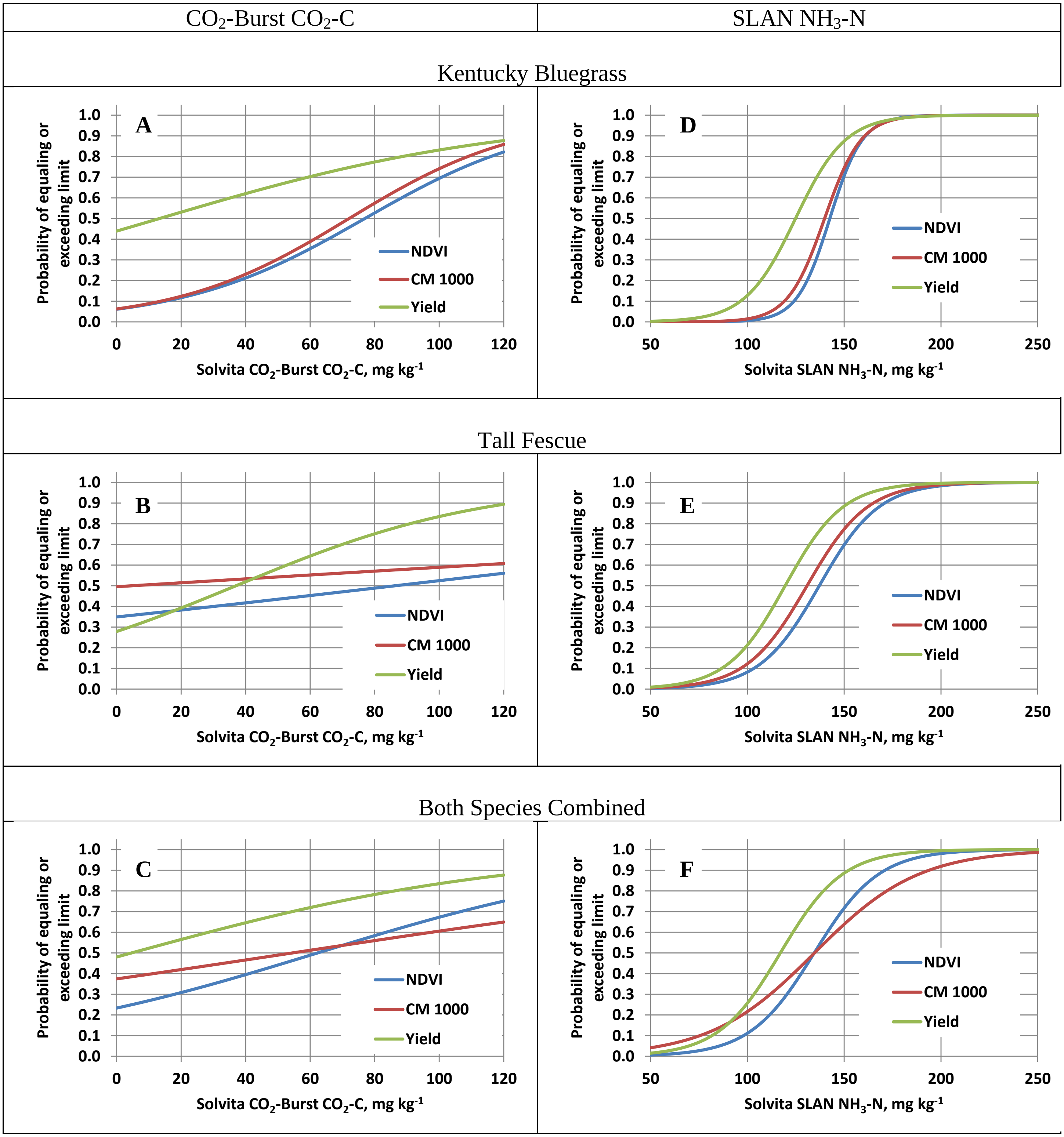

Fig. 3. Probability curves of equaling or exceeding the NDVI, CM1000, and clippings yield values of that obtained from the mean response of urea at the 150 and 200 kg N ha^{-1} rates in relation to Solvita® Soil CO_2-Burst CO_2-C concentrations (panels A, B, and C) and SLAN NH_3-N concentrations (panels D, E, and F) for the 2014 growing season. Mean urea response at the 150 and 200 kg N ha^{-1} rates for NDVI (relative unit), CM1000 (relative unit), and sum of the monthly clippings yield (g m^{-2}) values were 0.678, 370, and 137 for Kentucky bluegrass, respectively; 0.696, 461, and 173 for tall fescue, respectively; and 0.687, 415, and 155 across both species combined, respectively.

Fig. 4. Kentucky bluegrass response in 2014 to varying rates of organic-composted fertilizer.

Fig. 5. Tall fescue response in 2014 to varying rates of organic-composted fertilizer.

SUMMARY AND CONCLUSIONS

The preliminary 1st-yr results of this study suggest that the Solvita® SLAN Test kit shows promise in estimating cool-season turfgrass lawn response as a function of soil NH_3-N concentrations in soil samples collected in the spring prior to fertilization. The SLAN results were considered to be more reliable than the Solvita® Soil CO_2-Burst test kit results with these preliminary data. Much more variability was observed for the CO_2-C concentration data than for NH_3-N concentration data.

The SLAN data suggest that once Solvita® soil NH_3-N concentrations approach 200 mg kg^{-1} in a soil sample collected in the spring prior to N fertilization, there is a high probability that turfgrass response would be equivalent to or exceed the response that would be obtained from a split application of urea at 150 to 200 kg N ha^{-1} yr^{-1}. With these preliminary SLAN results, a delineation of general categories of turfgrass response to N fertilization, based on probabilities of obtaining benchmark values of NDVI, CM1000, and or turfgrass clippings from that expected from urea at rates from at 150 to 200 kg N ha^{-1} yr^{-1} can be proposed: when SLAN NH_3-N concentrations are <140 mg kg^{-1} in soil samples collected in the spring prior to N fertilization, there is a high probability (50% or greater chance) that the turf would respond to N fertilization.

When SLAN NH_3-N concentrations are between 150 and 200 mg kg^{-1}, there is about a 30% chance or less that turf would respond to N fertilization. In these cases, only moderate or low amounts of supplemental N would be required for optimum response. When SLAN NH_3-N concentrations exceed 200 mg kg^{-1}, there is a near 0% chance that turf would respond to 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 SLAN exceed 200 mg kg^{-1} increases the likelihood of N losses from the system and more problems with insect and disease pests.

The SLAN responses are very similar to the trends obtained in previous research on these same plots when predicting turfgrass response to the Illinois Soil N Test (ISNT)-N concentrations obtained from a spring soil sample across 5 years (2008-2012) (Geng et al., 2014). Although the ISNT-N concentrations that delineated response categories was higher than SLAN NH_3-N concentrations, the results from the 2014 growing season suggest that ISNT-N and Solvita® SLAN NH_3-N concentrations should be highly correlated, and of equivalent power in predicting whether or not Kentucky bluegrass or tall fescue lawns would respond to additional supplemental N fertilizer. However, this is speculative on our part at this time, and we would need to validate this by analyzing the archived 2008-2012 soil samples for SLAN NH_3-N concentrations, then correlating to existing ISNT-N values.

Since these conclusions are based on only one year of data, caution needs to be exercised in using the 2014 results and with their interpretation. As more data are collected, different conclusions and delineation ranges may come forth. However, we are encouraged with the preliminary results, and think that the tests (especially the SLAN) could provide an objective guide for N fertilization of cool-season turfgrass lawns.

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