Research Update: Foliar Fall Fertility Year One

Summary:

Low rates of N (0.4-0.8 lbsN/M) and medium rates of K (0.25lbsK/M) produced annual bluegrass plants that had greater cold tolerance rates when compared to plants that were treated with high rates of N or 0lbsK to high rates of K. While the plots that received no N in the fall did express good cold tolerance in the December and March relative cold tolerance tests, they had very low NDVI ratings, and extremely poor spring green-up rates. The preliminary data suggest that aiming for the 0.4-0.8 lbsN/M rate during the pre-acclimation period (late summer early fall) will provide annual bluegrass plants with the nutrition they need while preparing for winter, while still providing a reliable playing surface. It is important to note that plots that did not receive K did not have good tolerance. This emphasizes the need of potassium nutrition for annual bluegrass plants going into winter. This trend is in concurrence with the granular fall fertility trial that was completed in the spring of 2017.

Introduction:

Currently there is conflicting information on the effects of Nitrogen (N) focused fall fertility programs for improving cold tolerance during the acclimation and spring recovery (deacclimation) time-frames. In general, the literature shows a trend of positive effect for improving frost hardiness during the acclimation period with N applications (Taulavuori, et al., 2004). For example, early research by Carroll (1943) found fall application rates of N directly correlated with cold tolerance, and Carroll and Welton (1939) found high crown hydration levels were associated with increased risked to winter injury. Tompkins et al. (2000) found high rates of N directly correlated with increased crown hydration levels and a reduction is winter survival rates. Whereas, Powell et al. (1967) found fall applied N increased rooting and stimulated photosynthesis rate and carbohydrate production. Carbohydrate levels are thought to play an important role in preventing direct low-temperature kill to turfgrass crowns (Fry and Huang, 2004). Potassium (K) focused research with respect to cold tolerance has also shown variable results in turfgrass. Marklan and Roberts (1967) found that as K applications increased crown hydration levels decreased in creeping bentgrass, and Hurto and Troll (1980) found that tissue K levels positively correlated with cold tolerance of perennial ryegrass. Whereas Moody and Rossi (2010) found high K levels made creeping bentgrass more susceptible to snow mold injury. The roles of N and K in the plant are well known, and it is understood that when one is limited the nutrient use efficiency of the other is limited (Ebdon et al., 2013). Cold tolerance research with perennial ryegrass has shown some discrepancies with respect to cold tolerance. Hurto and Troll (1980) recommend a 2:1 N:K ratio, while Webster and Ebdon (2005) found that ratios of 1:4 – 2:1 improved winter injury prevention when N was applied at (5-15 $g^{-2}yr^{-1}$) with med – high levels of K (24-22$g^{-2}yr^{-1}$). A granular-focused N and K trial at the PTRC found that applying 4.88$gNm^{-2}yr^{-1}$ at biweekly rates of 1.22gNm^{-2} in combination with 4.88 – 9.76 gKm^{-2}yr-1 at biweekly rates of 1.22-2.44 gKm^{-2}, during the early fall pre-acclimation period, resulted in optimum cold tolerance levels and good spring recovery on an annual bluegrass putting green. While the results were useful in determining the negative effects of too much or too little N and K applied during the fall acclimation process, the rates were too coarse to fine-tune a foliar-based fertility program. The current study is focusing on the efficacy of using foliar applied N and K during the early fall pre-acclimation period. Steigler et al. (2013) found that Urea-based N sources had the lowest phytotoxicity potential and greater absorption rates when compared to other N sources, with most of the N being absorbed in the first 4 hours after application. Steigler et al. (2011) also found that applications in cooler weather resulted in greater absorption rates than during the hot summer months. This research suggests that using a foliar-based approach on cool season putting greens in the north may be a more efficient method for ensuring N gets absorbed effectively while minimizing potential loss to non-target areas. The purpose of this study was to observe the effects of foliar applied N and K on cold tolerance during the acclimation stage and deacclimation stage of annual bluegrass putting greens, and to determine if by using the foliar based approach would there be a potential decrease in the total amount of N and K applied in the early fall pre-acclimation period.

Materials and Methods:

An USGA sand-based annual bluegrass putting green that was constructed in 2012 was used to set up individual 1.5 x 0.75m plots at the Prairie Turfgrass Research Centre (PTRC) in Olds, AB. All plots were fertilized biweekly throughout the summer to ensure no deficiencies were present before the onset of the trial. Plots were arranged in a 2-factorial randomized complete block design with 4 replications for a total of 120 individual plots. All plots were fertilized with Urea-Ammonium Nitrate (UAN) (28-0-0) and potassium acetate (K) based upon their treatment number (Table 1) on 20 Aug, 1 Sept, 17 Sept, and 1 Oct, 2016. Soil tests were taken August 15th, 2016 before the onset of the trial and again on October 15th, to evaluate the effects of the foliar program on the soil nutrient profile. Tissue tests were taken on September 15th, and October 15th, 2017 for tissue nutritional status of the plant during the early and late fall acclimation process respectively. Both fertilizer sources were applied at a 4L 100m^{-2} spray rate using an even flat fan, and the applications occurred on days when no precipitation was forecasted for a 24-hour period in order to ensure optimum absorption potential of both nutrients (Steigler et al., 2013).

Table One: Summary of the treatments applied during the pre-acclimation period of 2016

Trt #	N Rate (lbs/M)	K Rate (lbs/M)
1	0	0
2	0.1	0
3	0.2	0
4	0.3	0
5	0.4	0
6	0	0.125
7	0.1	0.125
8	0.2	0.125
9	0.3	0.125
10	0.4	0.125
11	0	0.25
12	0.1	0.25
13	0.2	0.25
14	0.3	0.25
15	0.4	0.25
16	0	0.375
17	0.1	0.375
18	0.2	0.375

19	0.3	0.375
20	0.4	0.375
21	0	0.5
22	0.1	0.5
23	0.2	0.5
24	0.3	0.5
25	0.4	0.5
26	0	0.625
27	0.1	0.625
28	0.2	0.625
29	0.3	0.625
30	0.4	0.625

Year One – Preliminary Results and Discussion:

Cold Tolerance:

There were no statistical differences between the treatments for the October, December and April sampling dates when N and K treatments were explored as a 2-way factorial analysis. There was an interaction effect with the year one deacclimation data taken on March 21, 2017 between N&K suggesting that the uptake of one is reliant on the other one for helping with winter-long cold tolerance (Table Two). When explored further the results were similar to the granular fall fertility study where N rates played a factor in the changes in cold tolerance with the 0.2 lbN/M rate having a greater cold tolerance than the other treatments (Tables 3&4).

Table Two: ANOVA results for the LT_{50} results from the March 21, 2017 deacclimation sampling

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
N Rate (lbs/M)	4	4	26.38333	1.4981	0.2094
K Rate (lbs/M)	5	5	15.17500	0.6893	0.6328
N Rate (lbs/M)*K Rate (lbs/M)	20	20	237.49167	2.6971	0.0007*

Table Three: ANOVA LT_{50} results for N rates from the spring (March 21, 2017) deacclimation sampling when N levels were analyzed separately from K.

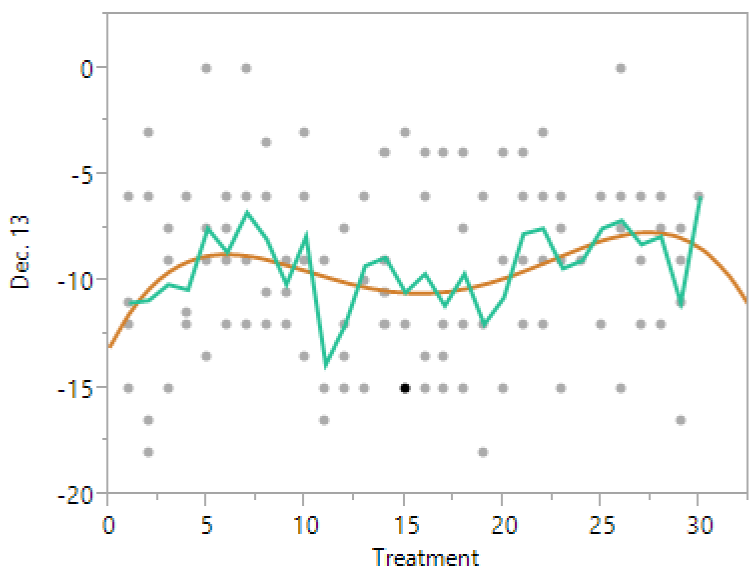
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Model	29	279.05000	9.62241	2.1855	0.0027*
Error	90	396.25000	4.40278		
C. Total	119	675.30000			

Table Four: Spring (March 21, 2017) cold tolerance values based on Nitrogen rates applied in the fall of 2016. Results followed by different letters within the column are statistically different according to the least square means Student's T-test (α= 0.05).

N Rate (lbs/M)	Least Sq Mean
0.1	-5.0625 a
0.3	-5.1042ab
0.4	-5.6250ab
0	-5.9375ab
0.2	-6.2708a

The December sampling date should reflect the greatest cold tolerance of the plants based from previous research performed here at the PTRC. When N&K were explored as combined treatments we see a trend where treatments that received applications of K at the 0.25lbsK/M (Trt#s 11-15, with 13 having the best cold tolerance) expressed greater cold tolerance (Fig.1). However, this is preliminary data and hopefully when the year two (to be applied early fall 2018) data is combined with this year one data the data will produce a stronger fit of the trends.

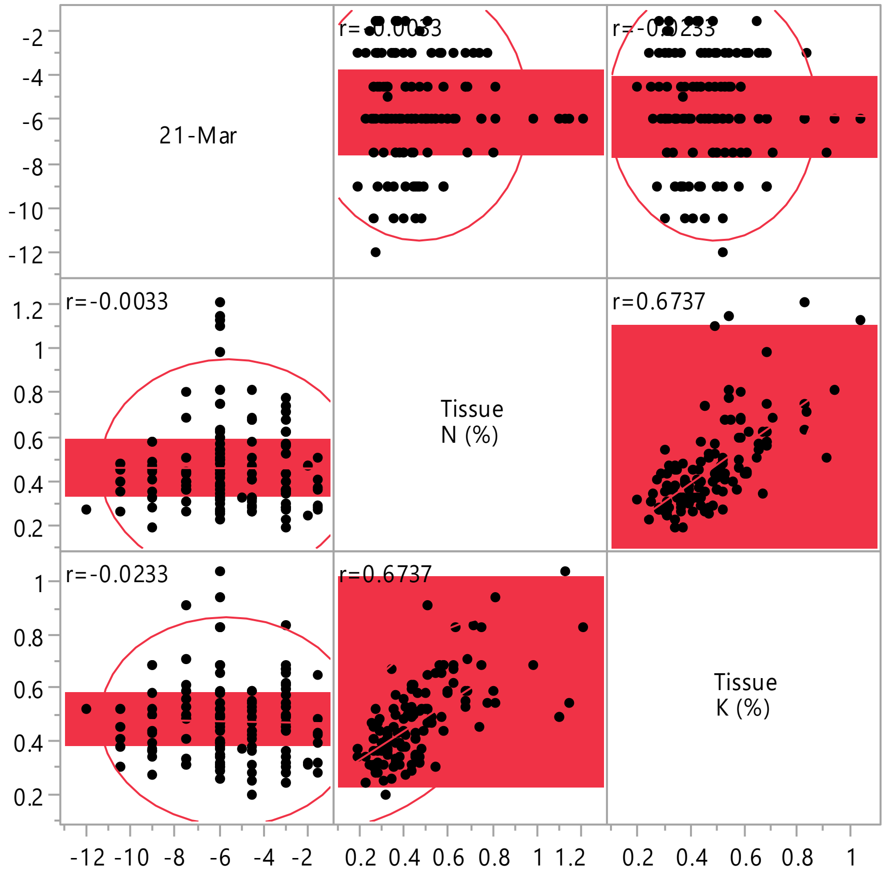
Figure One: LT_{50} results from the Dec. 13th sampling. Treatments numbers are outlined in Table One. The green line represents the areal fit line of the LS means of the LT_{50} results, while the orange line is the best fit line. In general, when N levels were low, and K was at 0.25lbs/M there was a greater cold tolerance in annual bluegrass. Rates of high N and/or high K resulted in a lower cold tolerance.



Tissue Nutrient Levels and Cold Tolerance:

At all sampling dates the data presented no strong correlations between cold tolerance and either N or K tissue nutrient status (Fig.2)

Figure 2: Scatterplot matrix of correlations. An R value that is close to 1 is considered to be a strong correlation, while a value closer to zero is not. The graphs show that there is a weak correlation between tissue N and tissue K content, which suggests that the two nutrients uptake and use in the plant are dependent upon the other, however there was not true correlation (r=0.0033) between the tissue nutrient status from the late fall and the March 21 Cold Tolerance levels.



Work Plan for 2018:

The putting green was established on August 10th, with its first mow on September 5. The irrigation has been fixed, and we are confident the poa was put to bed for the winter with a cover to minimize potential winter injury.

April – July the focus will be on increasing the density of the poa green to ensure a thick viable healthy green for the onset of the second round of the trial.

July 16 2018 sample poa green – both soil and tissue to ensure no nutrient deficiencies before the onset of the trial (August 15, 2018)

Sugar analysis of all crowns from both years of the trial will be performed during the late fall and winter months of 2018/2019. The department has invested in the equipment over the past six months and we have been working closely with the department chemist to ensure we will be able to run the samples with relative ease once they have all been processed.

Final report to the CTRF/QTRF April 30, 2019.

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