How I Would Manage Potassium on Cool-Season Turf: Part 1

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"There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact." – Mark Twain

Ouch. Sometimes the truth hurts. But, I feel this quote is often appropriate for our field of turfgrass science. Comparatively, there has been so little research done on turfgrass, and so many questions that remain to be answered that many of our recommendations are mostly conjecture based on a small number of highly specific studies that may or may not apply to your particular situation. For some, this may be frustrating; others may simply accept this as the way things work. Knowledge is a moving target, and the ability to reach a good decision based on the available information (some of it reliable, some of it less so) is the mark of an educated mind.

Education researchers tell us there is a progression to learning. We begin our lives learning facts and always trying to see issues as black and white. But at some point, we begin to realize that most of the problems we encounter do not fit the "black and white" model of thinking very well. While this realization comes to people in different ways and at different times, it is the goal of higher education to facilitate this paradigm shift. Most professors don't aim to simply fill the students' heads with facts, but to teach the students how to learn – so when the facts change (and they always do), the students will be just fine.

All this applies to turfgrass education as well. We need to start somewhere, so we start with simple black and white facts and generalizations. For example, potassium is a primary macronutrient and one of the top three nutrients implicated in less than optimal yield in food production. It doesn't have a structural role in the cell or form any significant organic molecules. Potassium is primarily involved in osmotic regulation of cells and as a co-factor in enzymes. While all of that is true, it probably doesn't help you do your job any better. So regarding the relevance of potassium to turf management, our black and white model says applying potassium improves cold, heat, drought, and wear stress. But when you try to get specific, things get complicated quickly. For example, when and how does potassium produce these benefits?

Does more potassium applied mean more stress tolerance? Is there a difference among the grasses in response to potassium? Does potassium increase cold tolerance, drought tolerance, and stress tolerance equally, or are some benefits more tangible than others?

So putting aside our black and white understanding of potassium, let's take a look at some of the research and try to understand potassium at a slightly deeper level. With few exceptions, the research described below was limited to a keyword search of peer-reviewed publications on Michigan State's Turfgrass Information File (TGIF) or from the Nutritional Requirements and Fertilization chapter of the American Society of Agronomy (ASA) Turfgrass Monograph (1992).

Cold Tolerance

The ASA Turfgrass Monograph (which is intended for researchers, not undergraduates) gives a more nuanced perspective of the role of potassium than we find in the standard textbooks: "Potassium plays a role in drought and heat tolerance, and especially cold tolerance of warm-season grasses". I'm intrigued by the possibility that the "winterizer" perception only applies to warm-season grasses. The authors (Drs. Tom Turner and Norm Hummel) go on to cite five studies that found potassium increases winter hardiness in warm-season grasses, but only found one study out of three that support the claim that potassium increases winter hardiness of cool season grasses (Table 1). More recently, Webster et al. (2005) provided evidence that potassium applied at 5-8 lbs/M (N ranged from 1-3 lbs/M) increased cold tolerance in perennial ryegrass. However, after studying this paper closely, I agree with the statistical conclusions but find the evidence practically insignificant – that is, not compelling enough to convince me that potassium should be used at those rates to improve cold tolerance in most situations.

In fact, our view of potassium as a "winterizer" may be due in part to Scotts. Marketing is more efficient when done on a national scale rather than a regional one, and so the winterizer fertilizers that are beneficial for warm season grasses were also marketed to the north, despite only weak evidence that potassium plays a role in cold tolerance for cool-season grasses. Unfortunately, I was unable to find a history of the use of the word winterizer before 1982, to this theory remains speculative for now.

Table 1. Summary of research on cold tolerance on cool season grasses.

Increases Cold Tolerance	No Effect on Cold Tolerance
Webster and Ebdon et al., 2005 (P. rye, when applied at 3-5x of N rate)	Turner, 1980 various
Beard and Rieke, 1966 (various, when applied at 0.5x of N rate)	Cook and Duff, 1976, tall fescue

Wear Tolerance

My literature search for peer-reviewed articles on the relationship between potassium and wear also turned up very few results (Table 2). This clearly shows how little research there is that specifically addresses how potassium affects wear. In fact, the source most often referred to when wear tolerance is cited as a benefit of potassium is an abstract (~170 words long) from a scientific conference in 1975. In that abstract Drs. Shearman and Beard reported that wear tolerance increase with increasing K applied, with maximum wear tolerance between 7 and 9 lbs K2O/M. Interestingly, all other wear tolerance studies have concluded that potassium has little to no effect on wear tolerance (Table 2). Yet, textbooks and popular press articles continue to list wear tolerance as a benefit of potassium, while ignoring the fact that the overwhelming majority of studies have not supported this conclusion. I attribute the staying power of the abstract to two things: 1) the authors are giants of turf research; 2) the conclusion is something that people want to hear (i.e. there's something easy you can do to improve wear tolerance). I do not question that the findings reported by Shearman and Beard were real for their particular situation. However, before putting wear tolerance firmly in the category of "benefit of potassium" and applying 7-9 lbs K2O/M/yr, I am going to need more evidence. For my money, the two papers by Hoffman et al. (2010a, 2010b) are the most conclusive work on potassium and wear to date. If you want the details, you'll need to read the papers, but they basically found wear tolerance and recovery were primarily (~95%) associated with nitrogen management, and had little if anything to do with potassium management. The biggest drawback of that study: it was only done for perennial rye, so we have to take a leap of faith to apply it to annual bluegrass, etc.

Table 2. Does potassium influence wear tolerance on cool season grasses?

Increases Wear Tolerance	No Effect on Wear Tolerance
Shearman and Beard, 1975, bentgrass	Hoffmann et al., 2010a, 2010b, p rye
	Carroll and Petrovic, 1991, Kentucky bluegrass and creeping bentgrass
	Hawes and Kecker, 1977, bentgrass

Heat and Drought Tolerance

So far, we've been unable to find strong evidence that potassium increase cold hardiness or wear tolerance. It's time for some good news. It appears that most of the research on the effect of potassium on heat or drought stress has come up positive, with only one study reporting no effect (Table 3). However, as you can see by the table, there are also relatively few studies on this issue and only one in the last 30 years (yikes). Many good questions remain to be answered, specifically: at what level(s) in the tissue does K convey these drought/heat benefits? Additionally, can this level be predicted by soil tests, or can we only get the appropriate drought benefit with supplemental applications? We simply don't have these answers yet. However, Dave Moody and Frank Rossi's recent research (building on previous work from Micah Woods) is finding that we've been measuring tissue potassium levels incorrectly. We normally look at the amount of potassium in the leaf per amount of dry tissue. But because the amount of potassium in the leaf is closely tied to the amount of water in the leaf, we should actually be looking at how much potassium relative to the amount of water in the leaf. This probably sounds trivial or esoteric, but I bet it will be critical to answering many of the remaining mysteries about potassium and drought tolerance.

Table 3. Does potassium influence heat and drought tolerance of cool season grasses?

Increases drought tolerance or recovery	No effect on drought tolerance or recovery	Increases heat tolerance
Haung, 2001	DiPaola and Engel (1976)	Pellet and Roberts (1963) - but only when N rate is high
Schmidt and Breuninger, 1981		
Waddington et al., 1978		
Escritt and Leff, 1970 - but only after 20 years of no K		

Disease Incidence/Severity

Finally, we come to diseases where there have been three flurries of activity over the past 40 years (Table 4). The first flurry, in the late 60s, reported that potassium applications decrease the incidence or severity of several diseases, including dollar spot. In the early 1980s, we find several studies that report no effect of potassium on several diseases, including dollar spot. Recently, we've seen three reports of excessive applications of potassium (≥8 lbs/M/yr) increasing the gray snow mold pressure. It is my view that if soil test levels are sufficient and potassium applications are reasonable (not too much more than your N rate), then potassium has no influence on disease pressure. It is probably only at the extreme ends of the spectrum where you'll find trouble.

Table 4. Does potassium influence disease incidence or severity of cool season grasses?

Increases disease incident / severity	Decreases disease incidence / severity	No effect
Gray Snow Mold, annual bluegrass, (Moody and Rossi, 2010)	Red Thread, Take All, Fusarium, (Goss and Gould, 1968, Goss, 1969)	Red Thread, P.rye, fine fesuce (Turner, 1980; Cahill et al., 1983
Snow Mold (species not identified), creeping bentgrass, (Woods et al., 2006)	Dollar Spot, bentgrass (Markland et al, 1969)	Leaf Spot, Kentucky bluegrass (Turner, 1980)
Gray Snow Mold, P rye (Webster and Ebdon, 2005		Dollar Spot, bentgrass (Waddington et al., 1978)
Brown Patch, bentgrass (Waddington et al., 1978)		

Conclusion

Based on the research, it appears that for cool-season grasses potassium may increase drought or heat tolerance, has very little to do with wear tolerance or cold tolerance, and excessive applications can increase gray snow mold. So given that, it seems potassium applications should be targeted in the summer – not in the fall as a "winterizer". In part two, I'll articulate my preferred application and soil testing strategy in a bit more detail.

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