Foliar Fertilization of Grass Grown for Seed[1]

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Abstract

In Southern Oregon, grass seed production occupies a small acreage, but is an important part of agronomic crop production. The high value of sod quality bentgrass seed (*Agrostis palustris* Huds.) led to some growers supplementing soil fertilizers with foliar fertilizers in an attempt to increase seed yield. However, this practice had not been tested under controlled conditions. The objective of this research was to determine whether growers could increase yield, reduce clean out costs, and/or improve seed test weight by applying foliar fertilizers during the reproductive phase of crop growth. Foliar fertilizers were applied "in boot", three weeks later, at both times, or at neither time to commercial fields of Kentucky bluegrass (*Poa pratensis* L.), perennial ryegrass (*Lolium perenne* L.),or bentgrass in a randomized complete block design. Foliar fertilizers contained N, P, K, S, Zn and B. Treatments were repeated over three growing seasons. Seed yield, test weight, and clean-out were not consistently or significantly improved by applying foliar fertilizers in boot and/or three weeks later. This was true regardless of the amount of soil fertilizer applied before the growing season. While yield was improved in certain instances, change in net return due to foliar fertilization was unpredictable, with large gains and losses both present. Based on these results, application of foliar fertilizers for grass seed production cannot be recommended for the cropping conditions of this study.

Introduction

Grass seed production in Southern Oregon occupies a small acreage relative to pears, forage, and cereals, but is an economically important component of agronomic crop operations. The high value of sod quality bentgrass seed (*Agrostis palustris* Huds.) led to some growers supplementing soil fertilizers with foliar fertilizers in an attempt to increase seed yield. One leading grower made a comparison in 1989 on two adjacent bentgrass fields, with one receiving two applications of Leffingwell foliar fertilizers. The grower estimated the foliar fertilizer increased yield and reduced cleaning costs, so that after subtracting material and application costs, his net return was increased by \$368 ac^{-1} where the foliar fertilizer had been applied. Based on this result, most grass seed growers in this area applied foliar fertilizers to all their fields in 1990. To evaluate the materials under more controlled conditions, they were tested at the Southern Oregon Research & Extension Center (SOREC) and in grower fields beginning in 1990. The objective of this research was to determine whether growers could increase yield, reduce clean out costs, and/or improve seed test weight by applying foliar fertilizers during the reproductive phase of crop growth.

[1] Use of product common or brand names is for the convenience of the reader only and does not imply endorsement or registration of the products by the author or Oregon State University, nor criticism of other products not named.

Materials & Methods

Foliar fertilizer experiments were conducted on private grower's fields as well as at the Southern Oregon Research & Extension Center (SOREC). The 1990 experiments included 'Scenic' Kentucky bluegrass (*Poa pratensis* L.) in its 5th year and 'Repell' perennial ryegrass (*Lolium perenne* L.) in its 1st year, both at the SOREC. The 1991 experiments included a different field of 'Repell' ryegrass (in its 1st year) at the SOREC as well as 'Penneagle' creeping bentgrass (*Agrostis palustris* Huds.) on the farms of Don Bohnert (3rd year) and Ron von der Hellen (also 3rd year). The 1992 experiment included the same field of ryegrass at the SOREC as was used in 1991, and also a different field of 'Penneagle' bentgrass (in its 3rd year) on the von der Hellen farm than was used in 1991 (the 1991 field was rotated out of bentgrass).

For the 1990 bluegrass site, individual treated plots were 80 in by 120 ft in size. For the 1990 ryegrass site, individual treated plots were 80 in by 240 ft in size. For the two 1991 bentgrass sites, individual treated plots were 80 inches by 200 ft in size. For the 1991 and 1992 ryegrass site, individual plots were 80 in by 108 ft in size. For the 1992 bentgrass site, individual plots were 10 ft by 150 ft in size.

Granular fertilizers were applied to the soil during the winter and spring prior to the growing season by the growers (or staff at the SOREC) as listed in Table 1. The fertilizers were applied by ground or air. To aid interpretation of experimental results, soil samples were taken from all but one of the experimental fields and analyzed for fertility levels (Table 2).

The bentgrass sites on farmer's fields were well fertilized during the fall and winter prior to the experiments. The ryegrass sites at SOREC were fertilized in winter at rates considered adequate, but not excessive, according to the Oregon State University soil test and fertilizer recommendation, except for 1991 when no soil fertilizer was applied. Thus the experimental conditions were such that should have demonstrated whether foliar fertilizers would have provided a benefit in addition to typical levels of soil-applied fertilizers, and also in one case where no soil fertilizer was applied.

For all experiments the foliar fertilizer treatments included "Early" (materials applied at booting), "Late" (materials applied about three weeks later), "Early+Late", and "Control" (no foliar fertilizers applied). Treatments were assigned in a randomized complete block design with four replications. Foliar treatments were applied using either a hand-pushed, bicycle frame-mounted spray boom that applied solution at 41.7 gal ac^{-1}, or a tractor-mounted spray boom that applied solution at 25.0 gal ac^{-1}. In 1990 and 1991 each foliar fertilizer application included a tank mixture in water of Leffingwell NutraPhos Super K at 5 lb ac^{-1} and SorbaSpray ZNP at 2 quart ac^{-1}. NutraPhos Super K had an analysis of 7-13-34-0 + 12.5 Zn (percent N, P_2O_5, K_2O, S, and Zn, respectively) and was derived from Potassium Nitrate and Zinc Potassium Phosphate complex. SorbaSpray ZNP had analysis of 10-12-0-1 + 2.0% Zn, derived from urea, Ammonium Phosphate, phosphoric acid, and Zinc Sulfate. In 1992 each application consisted of NutraPhos Super K and SorbaSpray ZNP at the same rates as before, with the addition of SorbaSpray ZBK at 2 quart ac^{-1}. SorbaSpray ZBK had an analysis of 1-0-6-0 + 1.0% Zn and 1.0% B, and was derived from Potassium Nitrate, Zinc Sulfate, and boric acid. This was included to determine if the added boron in the SorbaSpray ZBK had any effect on yield and clean-out.

When seed was mature, the fields were windrowed using standard equipment and then combined, using the farmer's combine in their fields or a Hege 125C plot combine for sites at the SOREC (Table 2). Measurements included clean seed yield, clean out (clean seed yield relative to seed yield collected at time of combining), and test weight. Analysis of variance was conducted with microcomputer SAS (SAS Institute, 1988). In 1990 and 1991 chemical analysis of the seed was also performed by Galbraith Laboratories, Knoxville, TN under agreement with Leffingwell. They used an Inductively Coupled Plasma emission spectrometer technique for all metals, a Leco Nitrogen Analyzer (model FP428) for N, and a Leco Sulfur Analyzer (model SC432) for S.

1990 Results

Bluegrass

No yield or test weight differences were observed between treatments for bluegrass (Table 3). Late and Early+Late applications significantly ($p=0.05$) increased seed Zn concentration and tended to increase seed Zn uptake, while other nutrient concentrations and uptake were little affected by treatment.

Ryegrass

Seed yield, test weight, and seed Zn concentration all tended to be greater with the Late and Early+Late treatments (Table 4). Due to the yield trend the seed uptake of N, P, K, and Zn tended to be higher for the Early+Late treatment.

1991 Results

Bentgrass

Seed yield tended to be higher for the Early+Late treatment at von der Hellen's farm, in contrast to Bohnert's farm where the control (None) had the highest seed yield (Tables 5 and 6). Test weight and clean-out were similar among all treatments at both locations. Concentration of N, P, K, and S were higher (in some cases significantly) for the Late treatment at Bohnert's than other treatments, while no trends were seen for those nutrients at von der Hellen's. Zn concentration and uptake was higher (sometimes significantly) for the Late and Early+Late treatments at both sites. Other nutrient uptake values generally followed the yield patterns.

Ryegrass

Seed yields were similar among all treatments (Table 7). Zn concentration was significantly higher for Early+Late than the Early and None treatments, and Zn uptake tended to follow the same pattern. N uptake was significantly greater for Early+Late than Late due to trends in that direction for both seed yield and N concentration.

1992 Results

Ryegrass

Yields were very low (less than 10% of 1991 yields) due to a severe leaf rust infestation, despite treatment with Bayleton (triadimefon) @ 0.34 lb a.i. ac^{-1}. This yield information was deemed irrelevant, and not included here.

Bentgrass

Yields, test weights, and clean out were not significantly different between treatments, although late application tended toward higher yield and lower test weight (Table 8). Because of the non-significant yield response, chemical analysis was not performed on seeds harvested in 1992.

Discussion

To bentgrass seed growers, a relatively small increase in seed yield and/or decrease in seed cleaning costs can represent a large change in net return, especially for sod quality bentgrass seed (which has sold for \$3.75 lb^{-1} in recent years). However, two applications of the foliar fertilizers tested cost about \$32 ac^{-1} for the material plus application costs (which can easily be \$18 ac^{-1} if applied by air).

In 1990 and 1991 seed yield and test weight results showed no consistent benefit from foliar fertilizers. This was true under conditions where high, moderate, and no soil fertilizer applications were made prior to the growing season. However, the 1990 and 1991 studies did not include the SorbaSpray ZBK material, a source of Boron. There was some disagreement as to the benefits of including B in the treatments. While application of B may certainly help in B deficient situations, one local report of detrimental B effects in 'Penncross' bentgrass was learned during the course of this study. Reportedly, Otto Bohnert (the breeder of both 'Scenic' and 'Pacific' Kentucky bluegrass) applied a B-containing foliar fertilizer to one Penncross field, while another field of Penncross across the fence did not receive the spray. He reportedly noticed that many seed heads of the 'PennLou' strain of Penncross were blank, while it normally produced a high percentage of the seed among in the three strains of Penncross. In the next field which did not receive foliar fertilizer, the PennLou strain seed heads were filled out well (Don Bohnert, pers. comm.).

However, to test the effect of including B in the treatments, the experiments included SorbaSpray ZBK in 1992. While the Late and Early+Late treatments did tend to have higher seed yield than the Early and None, the response was not statistically significant, and was relatively not much different than the results of the earlier experiments.

Conclusions

Bluegrass, ryegrass, and bentgrass seed yield, test weight, and clean-out were not consistently or significantly improved by applying foliar fertilizers in boot and/or three weeks later. This was true regardless of the amount of soil fertilizer applied before the growing season. While yield was improved in certain instances, change in net return due

to foliar fertilization was unpredictable, with large gains and losses both present. Based on these results, application of foliar fertilizers for grass seed production cannot be recommended for the cropping conditions of this study.

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References

SAS Institute. 1988. SAS/STAT user's guide. Version 6.03 ed. SAS Inst., Cary, NC.

Table 1. Management of experimental areas. Southern Oregon Research and Extension Center, Medford, OR.

	Management Operation		
Site & Year	Soil-Applied Fertilizer Rate[a]	Foliar Treatment Dates (Early, Late)	Swath & Combine Dates
Bluegrass 1990 (SOREC)	110-80-80-94 + micronutr.	April 13, May 4.	June 20, June 29.
Ryegrass 1990 (SOREC)	155-40-40-30 + micronutr.	May 11, June 4.	July 17, July 24.
Ryegrass 1991 (SOREC)	None	May 31,[b] June 18.	Aug. 8, Aug. 22.
Bentgrass 1991 (Bohnert)	164-104-172-72 + micronutr.	May 15, June 5.	Aug. 7, Aug. 27.
Bentgrass 1991 (von der Hellen)	164-94-102-66 + micronutr.	May 15, June 5.	Aug. 9, Aug. 28
Ryegrass 1992 (SOREC)	121-54-0-45	May 15, June 5.	July 28, Aug. 11.
Bentgrass 1992 (von der Hellen)	142-94-42-54 + micronutr.	May 22, June 16	Aug. 1, Aug. 20.

[a] Soil applied fertilizer during winter and spring prior to experiment, given as lb ac-1 N, P2O5, K2O, and S .

[b] Re-application made after treatment applied on May 29 was heavily rained upon within minutes after application.

Table 2. Soil test values for experimental fields[a]. Southern Oregon Research and Extension Center, Medford. OR.

Site	pH	P ppm	K ppm	Ca meg/100g	Mg meg/100g	Zn ppm
Bluegrass 1990 (SOREC)	5.8	14	100	12	2.2	na[b]
Ryegrass 1990 (SOREC)	5.8	12	90	10	2.0	na
Ryegrass 1991 (SOREC)	6.1	12	130	9	2.0	1.6
Bentgrass 1991 (Bohnert)	6.2	37	103	16	4.2	2.4
Bentgrass 1991 (von der Hellen)	6.1	54	134	9	2.2	3.5
Ryegrass 1992 (SOREC)	6.1	12	132	9	2.1	1.5
Bentgrass 1992 (von der Hellen)	NOT MEASURED					

[a]pH was measured by electrode in a 2:1 water to soil solution.
Phosphorus was extracted using the Bray method and measured using a RFA300 continuous flow analyzer.
Potassium, Ca, Mg, and Zn were extracted with ammonium acetate and measured with an atomic absorption spectrophotometer.

[b]Not analyzed.

Table 3. Bluegrass seed yield & nutrient analysis at Southern Oregon Research and Extension Center, Medford, OR, 1990.

	Treatments[a]				
Yield Parameter	None	Early[b]	Late[c]	Early +	$LSD_{0.05}$
Seed Yield ($lb\ ac^{-1}$)	504	485	526	501	NS
Test Weight ($lb\ bu^{-1}$)	23.0	23.0	22.6	22.8	NS
Clean Out (% clean seed)	67.7	69.9	72.3	68.4	NS
	Seed Nutrient Concentration				
N (%)	2.24	2.24	2.22	2.23	NS
P (%)	0.375	0.378	0.38	0.375	NS
K (%)	0.458	0.459	0.463	0.485	NS
Zn (ppm)	39.0b	41.0b	45.0a	44.6a	2.6
Mn (ppm)	84.4	84.6	85.4	81.4	NS
	Seed Nutrient Uptake				
N ($lb\ ac^{-1}$)	11.33	10.88	11.69	11.16	NS
P ($lb\ ac^{-1}$)	1.90	1.84	2.00	1.88	NS
K ($lb\ ac^{-1}$)	2.33	2.25	2.45	2.44	NS
Zn ($oz\ ac^{-1}$)	0.316	0.317	0.379	0.358	NS
Mn ($oz\ ac^{-1}$)	0.68	0.66	0.72	0.65	NS

[a] Each application consisted of Leffingwell NutraPhos Super K @ 5 $lb\ ac^{-1}$ and SorbaSpray ZNP @ 2 $qt\ ac^{-1}$, tank mixed in a solution applied @ 25 $gal\ ac^{-1}$.

[b] Early application when most seed heads were "in boot".

[c] Late application 3 weeks after early, a time when seed heads were visible on approximately 25% of the bluegrass plants.

[d] NS indicates no significant difference among all treatments and numbers followed by the same letter were not significantly different using the protected least significant difference test.

Table 4. Ryegrass seed yield & nutrient analysis at Southern Oregon Research and Extension Center, Medford, OR, 1990.

Variable	Treatments[a] None	Early[b]	Late[c]	Early + Late	$LSD_{0.05}$ [d]
Seed Yield (lb ac^{-1})	638	621	662	715	NS
Test Weight (lb bu^{-1})	17.7	18.8	20.3	19.1	NS
Clean Out (% clean seed)	72.1	75.8	78	69.3	NS
N (%)	2.3	2.29	2.31	2.26	NS
P (%)	0.402	0.399	0.401	0.407	NS
K (%)	0.811a	0.734b	0.762ab	0.742b	0.064
Zn (ppm)	35.75	36.75	39.25	39.00	NS
Mn (ppm)	66.2	66.0	70.2	64.2	NS
N (lb ac^{-1})	14.7	14.3	15.3	16.1	NS
P (lb ac^{-1})	2.56	2.48	2.65	2.91	NS
K (lb ac^{-1})	5.16ab	4.55b	5.03ab	5.30a	0.69
Zn (oz ac^{-1})	0.365	0.366	0.417	0.446	NS
Mn (oz ac^{-1})	0.67	0.66	0.74	0.73	NS

[a] Each application consisted of Leffingwell NutraPhos Super K @ 5 lb ac^{-1} and SorbaSpray ZNP @ 2 qt ac^{-1}, tank mixed in a solution applied @ 25 gal ac^{-1}.

[b] Early application when most seed heads were "in boot".

[c] Late application 3 weeks after early, a time when seed heads were visible on approximately 10% of the ryegrass plants.

[d] NS indicates no significant difference among all treatments and numbers followed by the same letter were not significantly different using the protected least significant difference test.

Table 5. Bentgrass seed yield & nutrient analysis at von der Hellen farm, 1991. Southern Oregon Research and Extension Center, Medford, OR.

Variable	Treatments[a] None	Early[b]	Late[c]	Early + Late	$LSD_{0.05}$ [d]
Seed Yield (lb ac^{-1})	564	600	552	637	NS
Test Weight (lb bu^{-1})	25.3	26.3	25.68	25.62	NS
Clean Out (% clean seed)	60.0	59.6	54.6	60.4	NS
N (%)	2.45	2.4	2.26	2.42	NS
P (%)	0.391	0.346	0.371	0.375	NS
K (%)	0.377	0.393	0.361	0.412	NS
S (%)	0.281	0.274	0.285	0.285	NS
Zn (ppm)	49.0	48.2	55.0	55.0	NS
Mn (ppm)	177	181	184	202	NS
N (lb ac^{-1})	13.8	14.4	12.4	15.2	NS
P (lb ac^{-1})	2.21	2.11	2.04	2.29	NS
K (lb ac^{-1})	2.13	2.37	1.97	2.58	NS
S (lb ac^{-1})	1.59	1.65	1.56	1.80	NS
Zn (oz ac^{-1})	0.44	0.45	0.49	0.52	NS
Mn (oz ac^{-1})	1.60	1.76	1.65	2.02	NS

[a] Each application consisted of Leffingwell NutraPhos Super K @ 5 lb ac^{-1} and SorbaSpray ZNP @ 2 qt ac^{-1}, tank mixed in a solution applied @ 25 gal ac^{-1}.

[b] Early application when most seed heads were "in boot".

[c] Late application 3 weeks after early, a time when very few seed heads were visible for von der Hellen bentgrass.

[d] NS indicates no significant difference among all treatments and numbers followed by the same letter were not significantly different using the protected least significant difference test.

Table 6. Bentgrass seed yield & nutrient analysis at Bohnert farm, 1991. Southern Oregon Research and Extension Center, Medford, OR.

Variable	Treatments[a] None	Early[b]	Late[c]	Early + Late	$LSD_{0.05}$ [d]
Seed Yield (lb ac^{-1})	1314a	1023b	1114ab	1115ab	260
Test Weight (lb bu^{-1})	28.3	27.4	27.9	28.3	NS
Clean Out (% clean seed)	85.9	81	89.9	79.8	NS
N (%)	2.43b	2.51ab	2.75a	2.42b	0.3
P (%)	0.352b	0.338b	0.412a	0.359b	0.042
K (%)	0.401	0.374	0.423	0.395	NS
S (%)	0.278b	0.267b	0.303a	0.273b	0.024
Zn (ppm)	47.0b	65.2ab	67.0a	84.5a	19.7
Mn (ppm)	252	260	231	228	NS
N (lb ac^{-1})	31.5	25.5	30.6	27.2	NS
P (lb ac^{-1})	4.60a	3.42b	4.58a	4.01ab	1.03
K (lb ac^{-1})	5.26	3.77	4.70	4.36	NS
S (lb ac^{-1})	3.64a	2.72b	3.38ab	3.04ab	0.69
Zn (oz ac^{-1})	0.99b	1.05ab	1.19ab	1.55a	0.53
Mn (oz ac^{-1})	5.26a	4.29ab	4.09ab	4.04b	1.20

[a] Each application consisted of Leffingwell NutraPhos Super K @ 5 lb ac^{-1} and SorbaSpray ZNP @ 2 qt ac^{-1}, tank mixed in a solution applied @ 25 gal ac^{-1}.

[b] Early application when most seed heads were "in boot".

[c] Late application 3 weeks after early, a time when seed heads were visible on approximately 10% of Bohnert bentgrass plants

[d] NS indicates no significant difference among all treatments and numbers followed by the same letter were not significantly different using the protected least significant difference test.

Table 7. Ryegrass seed yield & nutrient analysis, 1991. Southern Oregon Research and Extension Center, Medford, OR.

Variable	Treatments[a] None	Early[b]	Late[c]	Early + Late	$LSD_{0.05}$ [d]
Seed Yield (lb ac^{-1})	513	524	460	550	NS
N (%)	2.02	1.90	1.86	2.03	NS
P (%)	0.418	0.418	0.394	0.420	NS
K (%)	0.585	0.538	0.556	0.536	NS
S (%)	0.248	0.232	0.232	0.249	NS
Zn (ppm)	40.2c	44.2bc	46.5ab	48.8a	4.2
Mn (ppm)	134	120	128	115	NS
N (lb ac^{-1})	10.4ab	10.0ab	8.6b	11.2a	2.1
P (lb ac^{-1})	2.06	2.16	1.8	2.24	NS
K (lb ac^{-1})	3.19	2.92	2.6	3.07	NS
S (lb ac^{-1})	1.29ab	1.23ab	1.10b	1.40a	0.26
Zn (oz ac^{-1})	0.32	0.36	0.34	0.042	NS
Mn (oz ac^{-1})	1.07	1.00	0.91	1.03	NS

[a] Each application consisted of Leffingwell NutraPhos Super K @ 5 lb ac^{-1} and SorbaSpray ZNP @ 2 qt ac^{-1}, tank mixed in a solution applied @ 25 gal ac^{-1}.

[b] Early application when most seed heads were "in boot".

[c] Late application 3 weeks after early, a time when seed heads were visible on approximately 10% the plants.

[d] NS indicates no significant difference among all treatments and numbers followed by the same letter were not significantly different using the protected least significant difference test.

Table 8. Bentgrass seed yield & nutrient analysis at ven der Hellen farm, 1992. Southern Oregon Research and Extension Center, Medford, OR.

Variable	Treatments[a] None	Early[b]	Late[c]	Early + Late	$LSD_{0.05}$ [d]
Seed Yield (lb ac^{-1})	758	830	1047	925	NS
Test Weight (lb bu^{-1})	18.6	18.5	17.1	18.7	NS
Clean Out (% clean seed)	63.7	66.6	67.1	69.4	NS

[a] Each application consisted of Leffingwell NutraPhos Super K @ 5 lb ac^{-1} and SorbaSpray ZNP @ 2 qt ac^{-1}, tank mixed in a solution applied @ 25 gal ac^{-1}.

[b] Early application when most seed heads were "in boot".

[c] Late application 3 weeks after early, a time when seed heads were visible on approximately 25% of the plants.

[d] NS indicates no significant difference among all treatments and numbers followed by the same letter were not significantly different using the protected least significant difference test.