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Influence of potassium on helminthosporium cynodontis and dry matter yields of 'coastal' Bermudagrass*

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Abstract

A study was conducted to investigate K nutrition in relation to occurrence of a leaf spot disease identified as *Helminthosporium cynodontis* Marig. on 'Coastal' bermudagrass (*Cynodon dactylon* L. Pers.) grown on sandy soils of east Texas. Previously studied research plots of Coastal bermudagrass production via clipping removal were used. These were located on Darco (Grossaronic Paleudult; loamy, siliceous, thermic) and Cuthbert (Typic Hapludult; clayey, mixed, thermic) soils, typical of those used in forage production in east Texas. The influence of applied K at 112 and 224 kg K/ha with varying P on incidence of the disease, tissue K levels and exchangeable soil K was measured. Disease severity was curvilinearly related to tissue K levels. Midseason tissue K levels of 0,60% or less were associated with progressively increasing disease severity and decreasing dry matter yield. The first increment of 112 kg K/ha decreased disease severity and increased dry matter yield substantially. Phosphorus supply without K appeared to slightly aggravate the disease, possibly due to nutrient imbalance. Longevity of intensified forage production without K fertilization before development of the disease anomaly was soil dependent and varied from two production seasons for the Cuthbert soil to six seasons on the Darco soil. Differences in soil K reserves and soil depth were apparently responsible for the timing of the K related problem.

Introduction

Comprehensive reviews on plant nutrition and related diseases have been made (1, 5, 12, 15). Preponderance of information relating plant disease and nutrition indicates that balanced nutrition, rather than concentrations of any single element, is most critical in disease development.

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Potassium deficiency is frequently linked to disease susceptibility (7). *Leath* and *Ralcliffe* (10), in their review, cited forage nutrition work by *Schneider* and *Clark* (14) which showed high K rates reduced severity of *Stemphylium* Sp. leafspot and southern anthracnose (*Collectotrichum trifolii* Bains) of alfalfa (*Medicago sativa* L.), but the forage yields were not influenced. *Gentry et al.* (6) found that along with K, N level was extremely important in the incidence of *Helminthosporium vagans* Drechs. on fescue (*Festuca arundinacea* Schreb). High and low N rates produced less disease than medium rates. *Laughlin* (9) showed K fertilization decreased *Helminthosporium phlei* leaf spotting in timothy (*Phleum pratense*, L.).

Studies definitely linking K nutrition with fungal leafspot disease on 'Coastal' bermudagrass (*Cynodon dactylon* L. Pers.) are few (3, 4). This perennial grass is generally considered tolerant to many pathogens.

Coarse-textured soils are sometimes better suppliers of certain plant nutrients, such as K, than indicated from laboratory measurements of solution and exchangeable soil K (8, 13, 16). Consequently, production from deep-rooted perennial grasses, such as Coastal bermudagrass, could possibly be maintained for several years without an appreciable response to applied K. This study was conducted to determine whether K nutrition in Coastal bermudagrass was related to the incidence of leaf spot diseases, particularly *Helminthosporium cynodontis* Marig.

Materials and Methods

Coastal bermudagrass in production for 10 years on a Darco fs (Grossaronic Paleudult; loamy, siliceous, thermic) was studied in this experiment. Treatments applied to this soil consisted of a 3×3 complete factorial of P and K rates initiated in 1969 and continuing annually through 1975 with exception in 1970 and 1974 when P and K treatments were excluded in order to study residual P and K. Phosphorus rates were 0, 69, and 138 kg P/ha while K rates were 0, 112, and 224 kg/ha. Annual N rates were 504 kg N/ha for the period 1970 to 75 and 336 kg N/ha in the initial year, 1969. Phosphorus was applied in a single application at the start of the season while K was split into two equal applications and N into three.

The second phase of the experiment was conducted on a Cuthbert soil (Typic Hapludult; clayey, mixed, thermic) on an established stand of Coastal bermudagrass in production for 10 years. A 3×3 factorial with rates of 0, 59, 118; and 0, 112, 224 kg/ha of P and K, respectively, was initiated in 1974. Nitrogen was applied at 319 kg N/ha in split applications each year. Lower N rates were used on the Cuthbert soil than on the Darco soil because of its lower soil moisture supply (shallow surface). Six of the nine factorial treatments in both experiments were selected for this study. Experimental design was a randomized, complete-block with four replications.

Plot sizes were 2,7 m×2,7 m and 2,4 m×5,5 m on Darco and Cuthbert soils, respectively. Forage was harvested by clipping and removal from plots for 6 years prior to this study on the Darco and 1 year on the Cuthbert soil.

Clippings were generally obtained on a 4-week schedule when rainfall was adequate and 6-weeks when soil moisture stress was limiting plant growth.

The disease was identified and ratings were made by a plant pathologist on 10 subsamples of selected replicated treatments just prior to the midseason harvest (clipping No. 2). Plant samples from this clipping were dried at 17°C for 24 hours and ground to pass a 40-mesh sieve. Samples were prepared for chemical analyses through dry ashing and solution in acid (2). Plant analyses were performed for minerals including Ca, Mg, and K using atomic absorption spectroscopy.

Soil samples were taken at the time of disease ratings. The samples were air-dried, sieved, and extracted with N NH_4 OAc buffered at pH 7,0 for exchangeable K determination.

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Results and Discussion

Disease symptoms on Coastal bermudagrass resembling those reported by other investigators (3, 4) were observed through the growing season in 1975. Only slight evidence of the disease was apparent in the previous season (1974). Acute symptoms appeared on regrowth of the second clipping. Disease ratings for this clipping are shown in table 1 for plants receiving various rates of P and K. The disease appeared as brown and black oval or elliptical lesions 0,16 to 0,64 cm in length with tan to gray centers. Phosphorus fertilization without added K appeared to slightly aggravate the disease. This agrees with previous reports on nutrient imbalance and disease development (10). Essentially, all the disease reduction associated with added K was obtained with 112 kg/ha. Additional K (224 kg K/ha) had no effect on disease ratings at either location.

Dry matter production was inversely correlated with the severity of the disease (fig. 1) The deleterious effects from the disease were reflected in yield reductions ranging from 10% at the low rate of K to 46% when no K was applied. The yield reductions were a function of both stand loss and shorter plant heights. Phosphorus had no significant effect on yields during this growing season (data not presented).

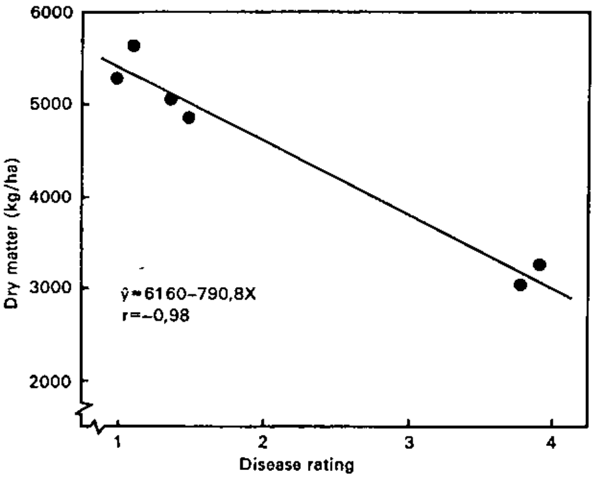

Fig. 1. Dry matter of Coastal bermudagrass in relation to severity of leaf spot disease Midseason harvest, Cuthbert soil.

Disease ratings and K concentrations in the forage were curvilinearly related (fig. 2). The negative linear component of the quadratic function was followed by a positive quadratic coefficient indicating only a slight or no decrease in the disease when tissue K levels increased beyond 0,80%. The data plot for dry matter production and tissue K was curvilinear and showed only a slight increase in plant growth as K concentrations exceeded 0,80%. This K level corresponded with a very low disease rating. The data further indicates that approximately 90% of maximum production of Coastal bermudagrass during midseason could occur on these soils with tissue K approximating 0,70%. These tissue K levels are considerably below the nutrient criteria levels reported earlier (11) and may be misleading without the consideration that the levels reported here are those for a single clipping grown during the mid-

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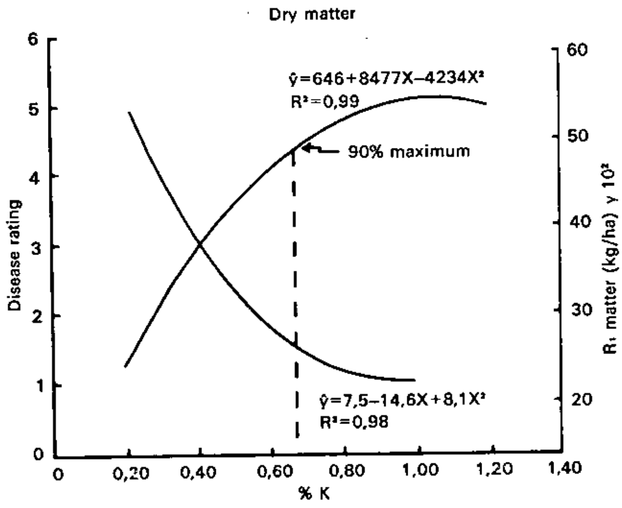

Fig. 2. Leaf spot disease severity and dry matter yield in relation to tissue K concentration. Midseason harvest, Cuthbert soil.

season when mineral content is usually at a seasonal low. Seasonal variations of tissue K in this grass can be quite wide as is shown in table 2. Considerable data on critical nutrient levels are reported as averages for several clippings during the season (11).

Characteristic K deficiency symptoms were evident on grass not receiving K, with less evidence of K deficiency as level of K fertilization increased. Potassium-deficient grass had severe scorching of tips and margins of older leaves. As the deficiency progressed, these leaves died and younger leaves showed tip and margin scorching. Tissue K levels of less than 0,70% were associated with K deficiency symptoms, while no deficiency symptoms were apparent as K levels approached 1,0%. Similar data for the Darco soil showed slightly higher tissue K and less acute K deficiency symptoms than on the Cuthbert soil.

Tissue concentrations of Ca and Mg in both the healthy and diseased grass were generally above the critical levels considered essential for good growth of Coastal bermudagrass (*J.E. Matocha,* unpublished data, 1976). Magnesium levels were inversely related with tissue K levels (table 2).

Exchangeable soil K showed consistent variation with applied K on both soils (table 1). The maximum difference in exchangeable K for soil supporting diseased vs. non-diseased grass was approximately 60 kg K/ha on the Cuthbert soil. This wide difference appeared specific to the Cuthbert soil since considerable narrower differences in exchangeable K were evident on the coarser textured Darco soil. Mineralogical difference, soil depth variation, and K uptake may be used in explaining the exchangeable K variation and the soil difference in production longevity prior to development of the leaf spot disease. The Darco soil contains larger amounts of highly weathered, interstratified micaceous materials than the Cuthbert soil (F.M. Hons. 1976. Potassium sources and availability in three east Texas soils. Ph.D. thesis, Texas A&M Univ., College Station). Therefore, nonexchangeable but slowly available K found on these soils may not be detected in routine laboratory estimations of available soil K. So it is conceivable that soils with low exchangeable

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Table 1 Influence of P and K fertilization on Helminthosporium cynodontis on Coastal bermudagrass and exchangeable soil K (0 to 15 cm depth)

Treatment			Darco fs		Cuthbert sl	
P			Disease		Disease	
Darco	Cuthbert	K	scale*	kg K/ha	scale*	kg K/ha
kg/ha						
0	0	0	2,7	17,9	3,8	38,1
138	118	0	3,1	13,4	3,9	38,1
0	0	112	1,1	18,4	1,4	44,8
0	0	224	1,0	40,3	1,0	82,9
69	59	112	1,3	17,9	1,5	49,3
138	118	224	1,0	29,1	1,1	100,8
L.S.D. 0,05			1,2	18	1,8	34

* Each value is average of 40 readings composed of 10 subsamples per plot in each of four replications. Rating index for top six blades:

1. 0 or trace only of leaf spots on leaves 5 and 6.
2. Leaf spots on 5 and 6 only > ¼ surface coverage.
3. Leaf spots on 4, 5, and 6 with 5 and 6 < ½ surface coverage.
4. Leaf spots on 3, 4, 5, and 6 with 5 and 6 < ½ surface coverage.
5. Leaf spots on 3, 4, 5, and 6 with 2 or more leaves dead.

Table 2 Influence of P and K fertilization on seasonal concentrations of selected mineral components in Coastal bermudagrass grown in Cuthbert soil

	Harvest				
Treatment	Early	Midseason			Late
P–K	K	K	Ca	Mg	K
kg/ha	%	%	%	%	%
0– 0	0,80	0,31	0,21	0,20	0,54
118– 0	0,68	0,28	0,18	0,18	0,44
0–112	0,95	0,64	0,15	0,15	0,62
0–224	1,56	0,98	0,15	0,14	1,10
59–112	1,34	0,64	0,16	0,13	0,70
118–224	1,45	1,08	0,16	0,12	1,10
L.S.D. 0,05	0,31	0,18	0,03	0,04	0,22

K rating but containing nonexchangeable K sources can supply deep-rooted plants such as Coastal bermudagrass with adequate K nutrition for several seasons and not show an appreciable response to applied K. The higher exchangeable K levels in the Cuthbert could be due to less intensive cropping to Coastal bermudagrass and consequent lower depletion rate of K.

The results of this study indicate that occurrence of *Helminthosporium cynodontis* Marig. leaf spot disease on Coastal bermudagrass grown in east Texas is related to K nutrition. The severity of the disease and frequency of occurrence will be highly dependent on the soils' capability to replenish depleted K, forage production levels, and previous fertilization.

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