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Iron-deficiency Chlorosis in Clovers

R. R. Gildersleeve and W. R. Ocumpaugh

Summary

Little information is available regarding the amount of genetic variation among and within *Trifolium* species for resistance to iron (Fe)-deficiency chlorosis. Two calcareous Parrita sandy clay loam sites that had a history of expression of Fe-deficiency chlorosis problems in small grains and forage sorghum was used to conduct field studies in 1985 to 1986 and 1986 to 1987. Six clover species: arrowleaf, berseem, crimson, red, rose, and subterranean clovers were compared for differences in dry matter production and expression of chlorosis symptoms. Clover species could be ranked for their adaptability to calcareous soil conditions: berseem = red = rose > crimson >> subterranean > arrowleaf. In addition, at least one subterranean clover cultivar ('Clare') has shown complete resistance, suggesting that differences may exist within as well as between clovers for resistance to Fe-deficiency chlorosis.

KEYWORDS: Calcareous soils/*Trifolium* spp.

Introduction

Iron-deficiency chlorosis symptoms have been observed at several Texas locations. The experiments reported here were conducted to determine whether differences exist among clover species for resistance to Fe-deficiency chlorosis when grown in calcareous soil and the extent of production losses in susceptible clovers.

Procedures

1985 to 1986

Field experiments were conducted from October 1985 through May 1986 on a calcareous Parrita sandy clay loam soil (pH = 8.0) that had a history of expression of Fe-deficiency chlorosis in small grains and forage sorghum and an adjacent site that supported normal plant growth. Cultivars of five clover species. ('Yuchi' arrowleaf, 'Bigbee' berseem, 'Dixie' crimson, 'Kondinin' rose, and 'Mt. Barker' subterranean clovers), two oat cultivars ('TAM 312' and 'Coker 227'), and common hairy vetch were planted with a Kincaid plot drill on Oct. 24, 1985. Seeding rates were 12 lbs/A for the clovers, 30 lbs/A for oats and 20 lbs/A for vetch. All legume seed was inoculated with an appropriate commercial *Rhizobium* strain just prior to planting. The experiments were arranged in a randomized complete block design with three blocks and two plots of each cultivar per block. Plot size was 5 ft X 20 ft with five rows per plot. One-half of the plots received a biweekly foliar application of a 2 percent w/v FeSO4 solution during vegetative growth (November to March).

Notes were recorded biweekly on plant height, evidence of chlorosis, and stage of growth. Visual estimates of chlorosis were recorded using the following scale: 0=no chlorosis, 1=0-25 percent chlorosis, 2=26-50 percent chlorosis, 3=51-75 percent chlorosis, 4=>75 percent chlorosis. Plots were harvested on February 17 and April 16, 1986 using a flail-type forage plot harvester. Dry matter yield estimates were corrected for percent stand and weed variations.

1986 to 1987

A field experiment was conducted from October 1986 through May 1987 on a calcareous Parrita sandy clay loam soil (pH 8.2) where 'Honeygrazer' forage sorghum showed severe chlorosis symptoms the previous growing season. Arrowleaf ('Yuchi' and 'Meechee'), berseem ('Bigbee'), crimson ('Dixie'), red ('Kenstar') and subterranean ('Mt. Barker' and 'Clare') clovers were inoculated with the appropriate commercial *Rhizobium trifolii* strain and planted on October 29, 1986. Two randomized complete block design areas were planted adjacent to one another, with three blocks each of all cultivars. One area received frequent irrigation with a sprinkler irrigation system to ensure expression of the Fe-deficiency chlorosis symptoms. Notes were recorded biweekly on plant height, stage of growth and evidence of chlorosis. Soil samples were taken as needed to determine changes in soil moisture. Plots were harvested on February 12 and March 24 as described for the 1985 experiment. Following each harvest, the irrigation system was moved to the area which had not received additional water the previous growth period.

Results and Discussion

1985 to 1986

Field chlorosis scores for the 'chlorosis' area of the 1985 to 1986 experiment are shown in Figure 1. 'Yuchi' arrowleaf, 'Dixie' crimson, and 'Mt. Barker' subterranean clovers began to exhibit Fe-deficiency chlorosis symptoms shortly after emergence, as did the oat cultivars and the vetch. Slight chlorosis symptoms (scores <2) were observed early in the growing season on the same clover cultivars and TAM 312 oats on the 'normal' area, but all plots rapidly outgrew the chlorosis symptoms (data not shown). Chlorosis symptoms remained on the susceptible cultivars in the 'chlorosis' areas until mid-January 1986, gradually disappearing as the soil moisture decreased. We experienced very dry conditions from December 1985 to April 1986 and all plots grew normally with no additional chlorosis symptoms appearing on susceptible cultivars. However, following the second harvest (April 16), and several heavy rains, chlorosis symptoms reappeared in 'Yuchi' arrowleaf and 'Mt. Barker' subterranean clovers, and TAM 312 oats ('Dixie' crimson clover had already senesced).

There were significant differences ($P<.01$) between cultivars for seasonal dry matter production (see Table 1) in the 1985 to 1986 experiment. However, no differences ($P>.05$) appeared within cultivars due to the Fe application or between the two soil areas of the experiment for total dry matter production. The authors believe that the dry conditions during the growing season masked expected losses in production in the suceptible cultivars. Therefore, the second experiment (1986 to 1987) included irrigation as needed to induce the chlorosis symptoms.

1986 to 1987

Site 1 received periodic supplemental water via a sprinkler irrigation system from November 1986 to February 12, 1987 (Harvest 1) and during April 1987. Site 2 received supplemental irrigation from February 13, 1987 to March 24, 1987 (Harvest 2). Irrigation was applied to maintain soil moisture in the 15 to 20 percent range. The chlorosis scores of susceptible clovers graphed in Figure 2 indicate that the symptoms could be consistently induced at both sites when additional water was applied.

Dry matter production by harvest of the clover cultivars at each site appears in Table 2. There are significant ($P<.05$) differences between cultivars in dry matter production at each site, but the presence or absence of chlorosis during a harvest period does not appear to affect yields in a consistent manner. However, Site 1 plots did generally yield less than Site 2 plots, and susceptible clovers always had more chlorosis symptoms at Site 1 (Figure 2), whether or not, supplemental irrigation was used to maintain high soil moisture during the growth period. Physical observations of the two sites suggest that soil variations are playing an important role in the inconsistant yields.

TABLE 1. TOTAL DRY MATTER PRODUCTION OF CLOVER, OAT, AND VETCH CULTIVARS, 1985 TO 1986

Cultivar	'Chlorosis' area		'Normal' area	
	−Fe	+Fe	−Fe	+Fe
	Pounds/Acre		Pounds/Acre	
Yuchi arrowleaf	4,251bcd	4,279bcd	4,068bcde	4,485bcd
Bigbee berseem	6,003a	5,961a	5,643a	5,647a
Dixie crimson	4,535abc	4,231bcd	4,890ab	4,523bc
Kondinin rose[1]	722f	1,035f	3,797f	3,358f
Mt. Barker sub	2,616de	2,756de	2,293g	2,533fg
Hairy vetch	4,590abc	5,370ab	3,921bcde	3,831cde
TAM 312 oats	3,488cde	3,569cde	3,533de	3,565cde
Coker 227 oats	4,288bcd	4,333bc	3,877cde	4,099bcde
LSD .05	1,535	1,535	974	974

[1]'Kondinin' rose clover was harvested only once during the season on the 'chlorosis' area, due to poor stands.

TABLE 2. DRY MATTER PRODUCTION OF CLOVER CULTIVARS AT SITES 1 AND 2, BY HARVEST, 1986 TO 1987

Cultivar	Harvest 1: 2/12/87		Harvest 2: 3/24/87	
	Site 1 (Irr.)	Site 2 (Non-irr.)	Site 1 (Non-irr.)	Site 2 (Irr.)
	Pounds/Acre		Pounds/Acre	
Yuchi arrowleaf	2,049bc	2,499cd	1,364cd	1,852b
Meechee arrowleaf	1,637c	1,649e	895d	1,743b
Bigbee berseem	4,261a	4,681a	2,092ab	2,401a
Dixie crimson	2,655b	1,965de	2,419a	2,621a
Kenstar red	1,704bc	2,639c	1,204cd	1,596b
Mt. Barker sub	2,062bc	1,882de	834d	1,640b
Clare sub	2,513bc	3,322b	1,752bc	1,817b
LSD .05	956	624	641	344

The results of these experiments suggest that high soil moisture conditions play an important role in the expression of Fe-deficiency chlorosis in susceptible clovers growing in calcareous soils. However, other soil and environmental factors must also be involved in whether or not expression of chlorosis translates into yield depression of a susceptible cultivar at a later date. Of the clover cultivars studied, 'Bigbee' berseem, 'Kenstar' red, 'Kondinin' rose, and 'Clare' subterranean clovers all appear to be resistant to the Fe- deficiency chlorosis and productive on calcareous soils. 'Dixie' crimson clover will show moderate chlorosis at early growth stages, but apparently recovers and is productive. 'Yuchi' and 'Meechee' arrowleaf clovers, and 'Mt. Barker' subterranean clover may all exhibit severe chlorosis symptoms and some production losses may occur.

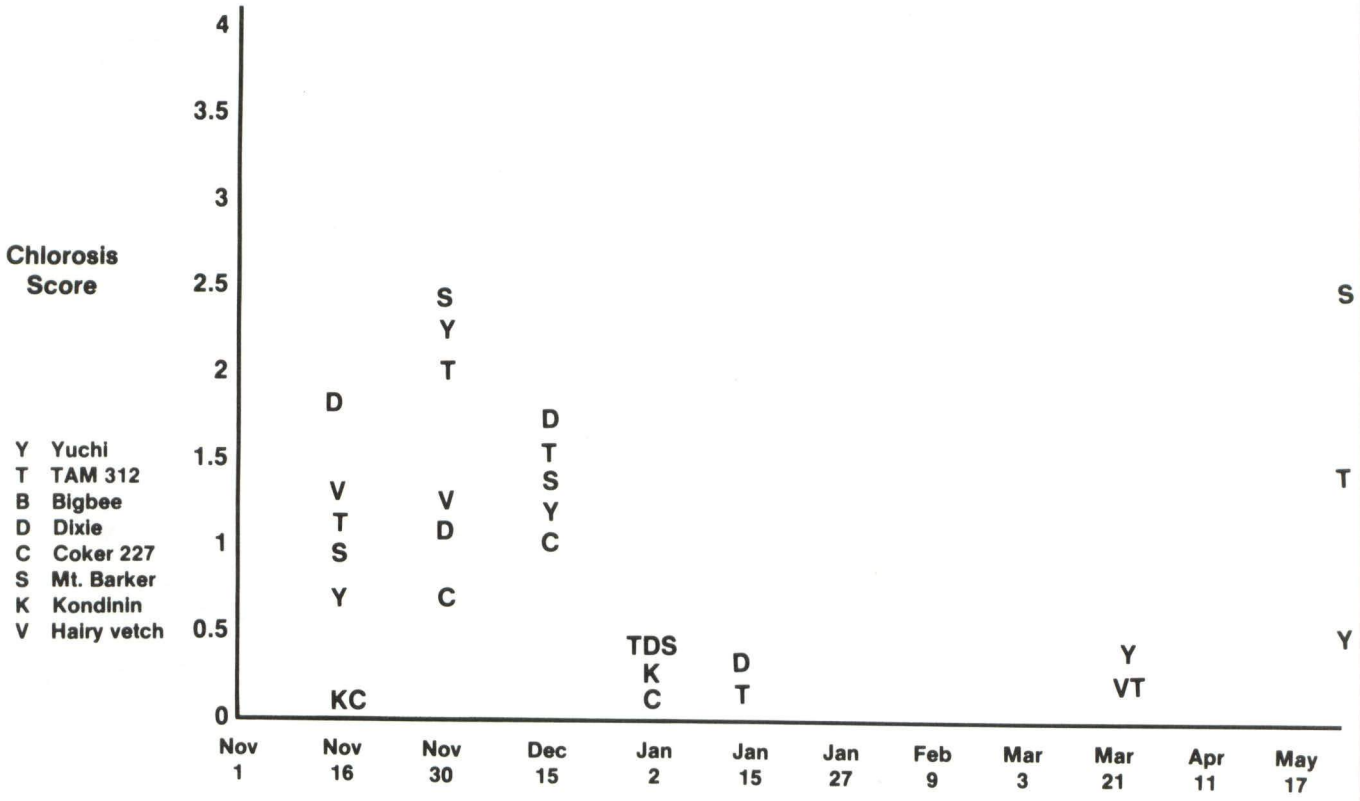

Figure 1. Visual chlorosis scores in Nov, 1985 to May, 1986.

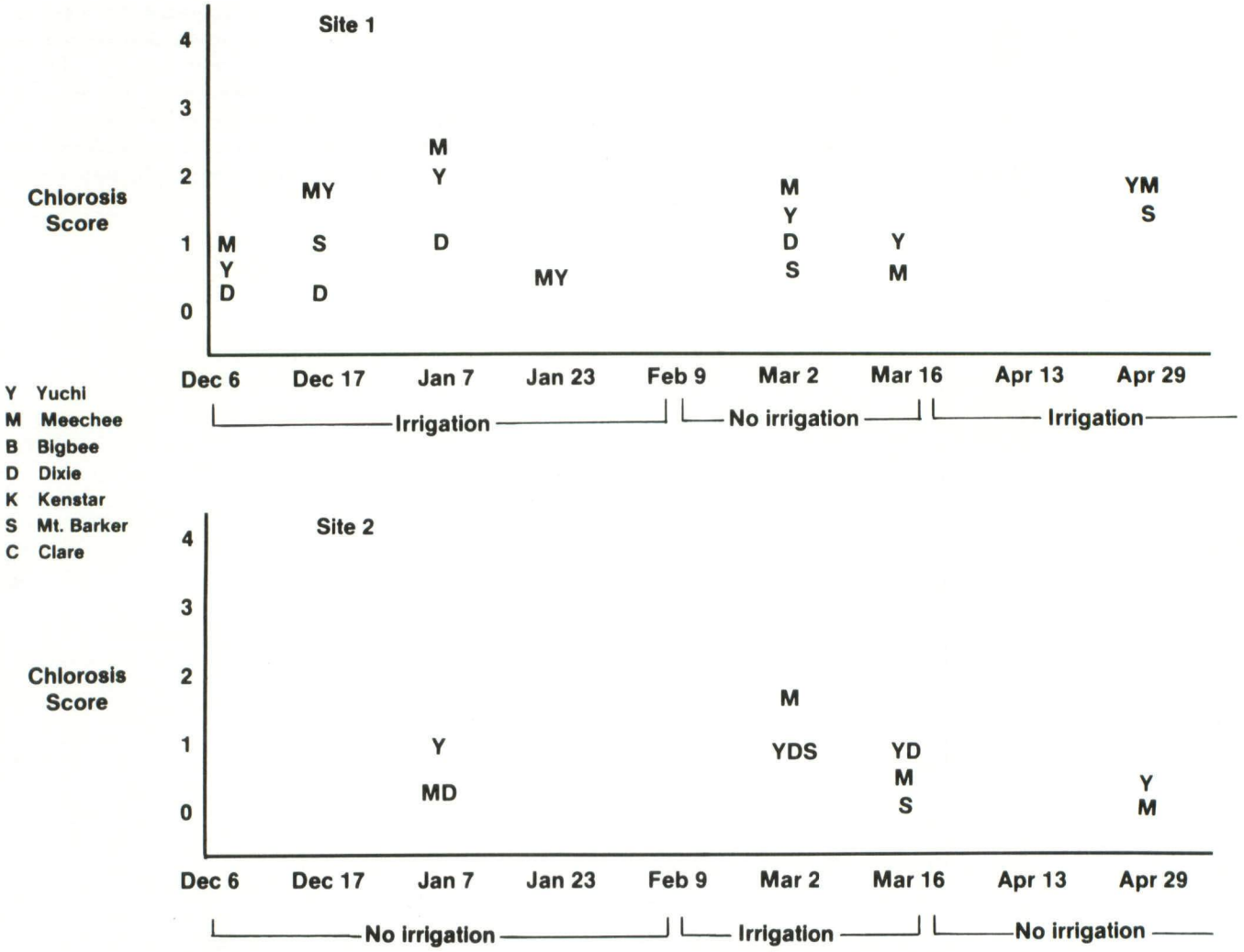

Figure 2. Visual chlorosis scores for Sites 1 and 2, without irrigation from Dec, 1986 to Apr, 1987.