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# A Study of the Grass Tetany Syndrome in Ohio

A. L. BARTA
E. M. KOHLER
J. F. UNDERWOOD

OHIO AGRICULTURAL RESEARCH AND DEVELOPMENT CENTER
Wooster, Ohio

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## INTRODUCTION

This publication describes the status of the grass tetany problem in Ohio. After a rather severe outbreak of grass tetany in the southeastern portion of the state during the spring of 1969, programs were initiated to investigate the scope of the disease and some of the plant and animal factors contributing to its development.

Hypomagnesaemia and the development of tetany occur when an animal is unable to obtain adequate amounts of magnesium from the diet to maintain a normal Mg level in the blood serum. Serum magnesium levels can fall to dangerous levels very rapidly (within 24 to 48 hours) on a magnesium-deficient ration, since cattle have no readily utilizable magnesium reserve. The disease primarily affects female ruminants near or shortly after calving when the animals' Mg requirements are high. This deficiency can occur on either hay or spring grass.

Tetany occurring on grass is termed spring tetany and is the most acute form. Symptoms develop rapidly and death may occur within a matter of hours. This is also the form most difficult to control from a management standpoint. The majority of spring cases occur within the first 1 or 2 weeks after the cattle are turned out to pasture.

Tetany occurring on hay or silage diets is referred to as winter tetany. This form of tetany is chronic in nature and has been the most prevalent type of tetany in Ohio for the past several years. However, in any individual herd, tetany is most likely to occur during the calving season whether this be winter or spring.

Although a great deal of research has been done both in this country and abroad on the cause of the disease, the actual mechanism responsible for triggering the animal into tetany is not known. Numerous plant, animal, and environmental factors have been associated with the disease, thus complicating study of the problem. The subject of grass tetany has been reviewed by several authors, including a book by Voisin (6) and most recently a comprehensive review and bibliography by Grunes *et al.* (1).

# INVESTIGATIONS

## Survey and Study of Grass Tetany Cases in Southeastern Ohio

Grass tetany in Ohio has occurred mostly in a 26-county area in the foothills of the Appalachian plateau (Figure 1). The residual soils in this area are derived primarily from sandstone and shale parent material, both of which are very low in Mg. The scattered deposits of limestone within this section are also high in calcium and low in Mg content. The predominant use of these local, calcitic limestones for liming has thus aggravated the soil Mg deficiencies in this area.

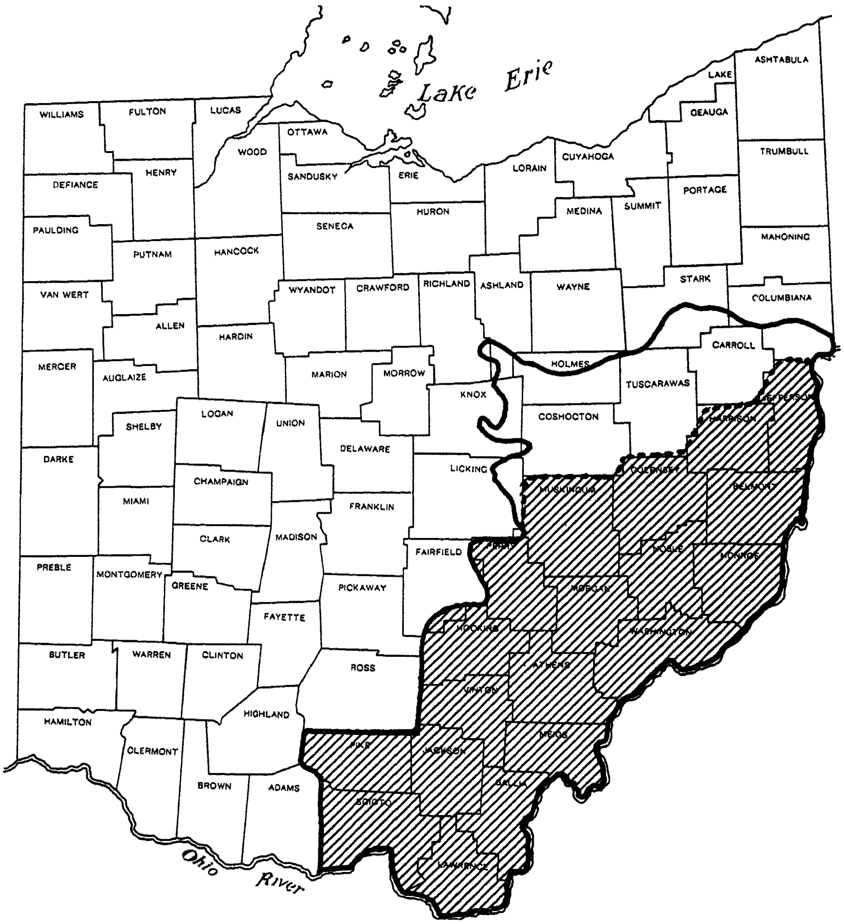


**FIG. 1.—Solid line indicates boundary of unglaciated sandstone and shale residual soils in Ohio. Diagonal hash area denotes the Jackson and McConnelsville extension areas where the tetany survey was conducted.**

An on-farm tetany survey was initiated and carried out through the Cooperative Extension Service in 1970 and 1971. The area surveyed was the 19-county area defined in Figure 1. These counties comprise the Jackson and McConnelsville extension areas.

Local veterinarians in the 19-county area were asked to collect blood samples, prior to treatment, from animals they suspected or diagnosed as having tetany. The serum sample and case history information were submitted to the state diagnostic laboratory at Reynoldsburg for mineral analysis. Whenever possible, samples were taken of the forage (hay, silage, or grass) being consumed when the animal was stricken. Soil samples from the affected pasture were also taken and analyzed for mineral content.

The objectives of this program were to: 1) determine the magnitude of the disease and the counties or localities where the problem was most prevalent, 2) ascertain the critical level of Mg in the forage which leads to deficiencies in the animals, 3) determine the critical level of Mg content in the soil which gives rise to Mg-deficient forages, and 4) assist farmers and veterinarians in the proper diagnosis of the disease.

A summary of the most representative cases reported in the 1970 winter and spring seasons is presented in Table 1. Many serum samples submitted in this survey had mineral analysis typical of milk fever (low calcium), which also occurs near calving and is somewhat similar in appearance to grass tetany. These cases are not included in Table 1.

The Mg content of the serum samples submitted varied from levels as low as 0.4 mg. of Mg per 100 ml. serum (hereafter referred to as mg. percent) to near normal levels. A serum Mg level of 1 mg. percent has been suggested to be a critical level for development of tetany (2). However, since normal serum magnesium levels are approximately 2 to 2.4 mg. percent, by definition cattle with levels below this are hypomagnesaemic. The precise level at which clinical tetany symptoms develop varies markedly among animals. The causes for these variations between animals are poorly understood, but can include such things as other nutritional factors, genetic factors, differences in digestive efficiency, age, lactation, estrus, and environmental stresses of several kinds.

The first five cases in Table 1 are representative of the acute spring form of tetany which occurs in cows on succulent, rapidly growing spring grass. Magnesium in the serum samples was very low (less than 1 mg. percent) except in case No. 1, where the animal had been treated previously and the serum sample was taken before the second treatment. The forage Mg contents of these five cases and all other samples in Table 1 were less than 0.2%. This has been suggested to be a critical level, since forages which contain less than 0.2% may not be able to supply the Mg

### TABLE 1.—Summary of 1970 Grass Tetany Survey

| Case No. | Forage and Date Sampled | Forage Mg | Forage K | Forage Protein* | Soil Mg† | Soil Lb. K/A. | Soil pH | Blood Mg | Blood K | Blood Ca | Blood iP | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (Percent Dry Wt.) | | | | | | (mg./100 ml. serum) | | | | |
| 1 | Pasture 4-20 | 0.14 | 2.7 | 26 | 7.5 | 365 | 6.6 | 1.3 | 12 | 10.0 | 3.5 | Cow treated twice. Blood sample taken before second treatment. Feeding 6% MgO in salt. |
| 2 | Pasture 4-20 | 0.17 | 2.6 | 27 | 8.3 | 290 | 6.1 | 0.4 | 18 | 6.8 | 3.5 | Feeding 6% MgO in salt. |
| 3 | Pasture 4-26 | 0.12 | 2.0 | 19 | 10.9 | 310 | 5.9 | 0.6 | 16 | 8.0 | 5.3 | |
| 4 | Pasture 4-22 | 0.15 | 3.1 | 21 | 22.2 | 515 | 6.2 | 0.5 | 26 | 9.3 | 4.0 | |
| 5 | Pasture 4-1 | 0.17 | 3.3 | 23 | 9.5 | 330 | 6.1 | 0.5 | 20 | 7.0 | 4.0 | |
| 6 | Silage 2-17 | 0.16 | 2.5 | 11 | 11.0 | 181 | 6.4 | 0.5 | — | — | — | |
| | | | | | | | | 0.4 | — | — | — | Two animals affected. |
| 7 | Hay 3-23 | 0.08 | 1.6 | 6 | 13.8 | 340 | 6.9 | — | — | — | — | |
| 8 | Hay 3-24 | 0.14 | 0.83 | 6 | — | — | — | 0.6 | 16 | 3.8 | 3.0 | |
| | | | | | | | | 0.4 | 17 | 7.0 | 7.8 | |
| 9 | Hay 3-28 | 0.08 | 0.9 | 4 | — | — | — | 1.9 | 15 | 6.4 | 2.0 | Very mature hay. |
| 10 | Pasture 4-28 | 0.15 | 1.9 | 21 | 12.9 | 300 | 6.5 | — | — | — | — | |
| 11 | Hay | 0.09 | 8.4 | 4 | 9.4 | 250 | 6.6 | — | — | — | — | Very mature hay. |
| 12 | Hay | 0.13 | 2.3 | 8 | 6.3 | 330 | 5.5 | — | — | — | — | |

*N x 6.25%
†Percent Mg base saturation

required by the animal to maintain a normal level in the blood serum (2). This 0.2% critical level pertains only to the animal's Mg requirements, since grasses can grow normally with this level of Mg and only become deficient if the concentration in the plant drops to 0.1% or less.

Several hay samples collected from winter tetany cases (Nos. 7, 9, and 11) had Mg levels below 0.1%, indicating a severely Mg-deficient forage. Two of these samples also had very low levels of potassium and protein and were described as very mature hay. These cases illustrate a situation which is not uncommon in Ohio and elsewhere. Much poor quality hay, which does not meet the minimum nutritional and energy requirements of the animals, is fed to livestock. In effect the animals are in malnutrition while consuming all the hay they want. Tetany may occur as a result of this nutritional deficiency situation.

The soil test analyses from the tetanogenic pastures showed a wide range of Mg content, but the majority of samples had Mg saturation values of less than 15%. This value has been suggested to be a critical value for soil Mg saturation and appears to be a suitable criterion from the limited data collected in this survey. In addition, two recent soil test summaries of farmer samples from this area, processed by The Ohio State University soil test laboratory, have shown that 76% and 80% of the samples, respectively, were below 15% Mg base saturation. This clearly illustrates the magnitude of Mg deficiencies in this area and the need for implementing preventive and corrective measures.

Another characteristic of the soil test analyses in Table 1 is the generally high level of available soil potassium which is paralleled by a generally high level of K in the plant. High levels of soil K are known to interfere with plant Mg uptake (1, 4), while high levels of K in the forage may reduce Mg uptake or utilization within the gut of the animal (2). Case No. 4 is particularly significant. Although the soil Mg saturation is well above 15% (22%), an Mg-deficient forage was produced which ultimately resulted in grass tetany. This soil sample was taken from a pasture which had received large quantities of poultry manure (high K content) during recent years. The high level of K in the soil sufficiently inhibited or reduced the plant uptake of Mg so that Mg-deficient forage resulted. Thus, the soil K content as well as the Mg content must be considered when interpreting soil tests with regard to their tetany-producing potential.

Another observation made in this study was that a majority of the spring-type tetany cases occurred within a 1-week period from April 20 to 28. This corresponded to the time when pastures attained sufficient growth for grazing to begin. This observation supports the findings of other researchers that the high risk period for spring tetany is the first several weeks of early grass growth when the grass is young and growing rapidly.

Table 1 shows that two grass tetany cases (Nos. 1 and 2) occurred even though the animals' diets were being supplemented with 6% magnesium oxide (MgO) in salt. While feeding MgO in salt has been very effective in reducing winter tetany, it has not been completely satisfactory for the prevention of spring tetany. Since the animal cannot store Mg, it must obtain its supply daily through the diet. The animals may not consume the salt:MgO mixture every day when put on pasture or, if they do take it, they may not obtain sufficient Mg through the salt mixture to meet their needs at his critical time. More dependable preventive measures will be discussed later.

Only a few cases of tetany were reported in the 1971 season. Very cool temperatures and dry soil conditions retarded early pasture growth. There was not the succulent rapid growth which occurs in most years. Environmental conditions are known to be a factor in the seasonal variation in incidence of grass tetany. Unfortunately, many of the reasons for these seasonal variations are not completely known or well understood.

### Grazing Studies on a Selected Herd

A grazing study was carried out in spring 1970 and spring 1971 on a herd of 17 pregnant or lactating beef cows. The purpose of this study was to monitor blood and forage mineral content prior to and after the animals were turned out to pasture in early spring. It was hoped that tetany could be induced in one or more animals so that the

**TABLE 2.—Analysis Summary of 1970 Grazing Study.**

| Date Sampled | Blood Serum Analysis* (mg./100 ml.) | | | | Forage Mg Concentration (Percent Dry Wt. Basis) | | |
|---|---|---|---|---|---|---|---|
| | Mg | K | Ca | iP | | | |
| 3-19 | 1.75 | 18.2 | 10.9 | 6.3 | Hay | 0.14 | |
| 3-30 | 1.75 | 19.0 | 8.9 | 5.7 | Hay | 0.14 | |
| | | | | Initiation of Grazing | | | |
| 4-8 | 1.63 | 17.8 | 8.8 | 6.2 | Hay + Grass | 0.19 | Increasing grass consumption |
| 4-16 | 1.29 | 17.4 | 8.8 | 6.5 | Hay + Grass | 0.18 | ↓ |
| 4-20 | 1.12 | 15.3 | 8.5 | 6.1 | Grass | 0.20 | 100% Grass |
| 4-23 | 1.09 | 16.7 | 9.5 | 5.0 | Grass | 0.21 | |
| 4-27 | 1.79 | 16.3 | 9.2 | 4.6 | Grass | 0.21 | |

*Analysis mean of 17 (8 to 10 yr. old) pregnant or lactating beef cows.

blood and forage mineral patterns could be evaluated and related to the onset of tetany. An application of 150 lb. of nitrogen per acre was applied in early spring of each year to maximize early grass growth. The test pasture in 1970 was an orchardgrass pasture located at the Southeastern Branch of OARDC, Albany, Ohio.

A summary of the test results for the 1970 season is presented in Table 2. Unfortunately, no animals contracted tetany, even though the average serum Mg content dropped to a very low level on the samples collected April 23. The blood serum Mg content dropped rapidly as the animals gradually went from hay to grass forage (March 30 to April 23), readily illustrating the depressing effect of young, rapidly growing pasture on blood Mg levels. Blood levels of potassium, calcium, and phosphorus remained in the normal range over the course of the experiment.

The soil Mg content of the test pasture was 22% Mg base saturation. This level is above the critical 15% Mg base saturation and is reflected in the forage Mg content which was near or above the *safe* level of 0.2% during the early growth stages. Grass tetany might not be expected to occur on this particular pasture since the soil and plant Mg levels were near or above the so-called safe level. However, the rapid decline in blood serum Mg when grazing began indicates that the utilization or availability of the plant Mg to the animal was reduced.

The grazing study carried out in the 1971 spring season was located on a farm in Jackson County with a very Mg-deficient soil (5% Mg base saturation) and a history of grass tetany problems. Very low levels of serum Mg were again noted after the animals were placed on pasture, but no tetany developed (Table 3). Mean blood serum Mg content dropped to less than 1 mg. percent and several animals had blood Mg levels of 0.2 to 0.3 mg. percent but appeared to be normal. The Mg

**TABLE 3.—Analysis Summary of 1971 Grazing Study.**

| Date Sampled | Blood Serum Analysis* (mg./100 ml.) | | | | Forage Mg Concentration (Percent Dry Wt. Basis) | |
|---|---|---|---|---|---|---|
| | Mg | K | Ca | iP | | |
| 4-15 | 1.15 | 18.9 | 6.9 | 7.2 | Hay | 0.14 |
| 4-22 | 1.16 | 20.2 | 8.3 | 6.9 | Hay | 0.12 |
| | **Put on Pasture 4-27** | | | | | |
| 4-29 | 1.10 | 18.5 | 9.2 | 5.5 | Grass | 0.14 |
| 5-4 | 0.79 | 18.8 | 8.8 | 4.8 | Grass | 0.14 |

*Analysis mean of 16 (8 to 10 yr. old) pregnant or lactating beef cows.

content of the forage was very low (0.14%), much below the critical or safe level of 0.2%.

One factor which may have contributed to the absence of tetany was the extremely dry and cooler than average temperature before and during the grazing study. Grass growth was not rapid and succulent but was greatly retarded due to weather conditions. However, it is difficult to reconcile the fact that extremely low levels of blood serum Mg were noted in some animals, even though the environmental conditions and pasture growth were judged to be not conducive to the development of grass tetany.

Although the primary objective of these grazing studies was not achieved (i.e., the induction of grass tetany), several conclusions may be drawn from the results of this study. It is obvious that severe hypomagnesaemia may occur readily without the subsequent development of clinical tetany when animals are turned out to pasture. Other factors (or stresses) must be involved which trigger the animal into tetanogenic convulsions after the animal has become hypomagnesaemic. Thus, blood serum Mg levels *per se* cannot be relied upon to determine the immediate imminence of tetany. Deficient serum samples from a number of animals in a herd, however, may indicate a potential danger which would require preventive measures. Serum Mg content is useful in the diagnosis of clinical cases, since deficient Mg levels are always associated with clinical tetany.

### Agronomic Studies on the Effects of Season, Species, and Nitrogen Fertilization on Forage Mineral Content

High rates of nitrogen fertilization on Mg-deficient grass pastures are known to increase the incidence of grass tetany (2, 3). The effect of N fertilization on the mineral content of several cool season grasses was studied on established grass plots in Washington County. Table 4 presents the Mg, K, and N contents of three common pasture grasses after fertilization with nitrogen at the rate of 100 lb. of N per acre.

Nitrogen fertilization resulted in marked increases in the plant Mg, K, and N concentrations of all three species. The increased Mg concentration with N fertilization is especially significant, since there has been a rather common belief that the increased plant growth resulting from N fertilization tended to *dilute* the Mg in plants and thus reduce overall Mg content. The findings of this study, plus similar findings by R. L. Reid *et al.* (4) in West Virginia and others, indicates that N probably increases the ability of the plant's root system to take up Mg from the soil and thus to increase the overall content in the plant.

Nitrogen fertilization also increased the potassium and nitrogen or crude protein content of the forage. Both of these factors have been

**TABLE 4.—Effects of Nitrogen Fertilization on Mg, K, and N Content of Several Grasses.***

| | | 0 Lb. N/Acre | 100 Lb. N/Acre |
|---|---|---|---|
| Bluegrass | Mg | 0.14 | 0.18 |
| | K | 1.61 | 2.4 |
| | N | 2.2 | 3.9 |
| Orchardgrass | Mg | 0.14 | 0.17 |
| | K | 2.58 | 2.78 |
| | N | 2.66 | 3.52 |
| Tall Fescue | Mg | 0.17 | 0.23 |
| | K | 2.01 | 2.62 |
| | N | 1.90 | 3.20 |

*Means of five samples taken from 4-16 through 5-6, 1970, on plots in Washington County, Ohio.

associated with reduced availability of plant Mg to the animal (2). Consequently, even though nitrogen-fertilized grass has a higher percent Mg content, the animal may absorb and utilize less total Mg than it could with non-nitrogen fertilized forages.

The adverse effect of N fertilization on plant Mg availability should not deter implementation of a pasture fertilization program designed to increase yield and cow-carrying capacity. Nitrogen fertilization can greatly increase grass pasture production. In considering the potential tetany problem associated with high rates of nitrogen fertilization, the following management suggestions may be helpful in reducing spring tetany: 1) Split nitrogen application, with half being applied in early spring and the remainder after the first cutting of hay or in early June. This system will reduce the danger inherent in one heavy application. 2) Keep the most tetany-susceptible animals (older cows near calving) off N-fertilized pasture for the first several weeks of the grazing season. 3) Increase the Mg uptake by the animals by dusting the grass with 25 to 30 lb. of magnesium oxide per acre when the grass is 3 to 4 inches tall. This treatment will last for several weeks and has been very effective in reducing tetany losses on lush spring pasture, probably because it forces the animal to eat the readily utilizable Mg (5).

Plant magnesium concentration varies with the stage of growth, as shown in Table 5. Mg concentration is usually highest in the earliest growth stages and declines as the plant reaches maturity. Leaves have a higher Mg concentration than the stems and as the grass grows and matures, the proportion of leaves to stem decreases, thus lowering total Mg concentration. However, grass regrowth after the first crop has been har-

**TABLE 5.—Effects of Stage of Growth on Plant Mg Concentration.**

| Mg-Sufficient Soil | | Mg-Deficient Soil | |
|---|---|---|---|
| Sampling Date | % Mg | Sampling Date | % Mg |
| 4-19 | 0.23 | 4-10 | 0.15 |
| 5-3 | 0.22 | 4-24 | 0.15 |
| 5-10 | 0.18 | 5-27 | 0.13 |
| 5-28 (H)* | 0.14 | 6-11 (H) | 0.12 |
| 6-10 (R)† | 0.25 | 6-22 (R) | 0.19 |

*Forage harvested as hay
†Regrowth

vested will tend to be higher in Mg concentration when compared to the first crop at a similar stage of growth (Table 5). Plant uptake of Mg is influenced by soil and air temperatures and as these temperatures increase, plant uptake of Mg increases. This results in plant Mg concentration being highest in the summer months and lowest in the spring and fall.

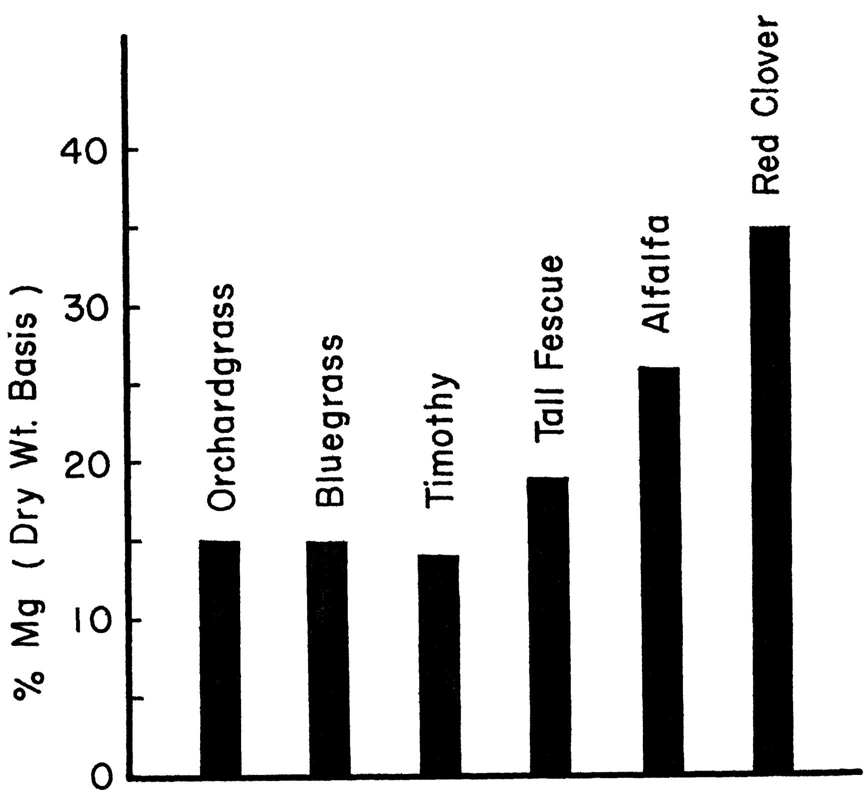


FIG. 2.—Mg content of several forage species.

Forage species also vary in their Mg content (Figure 2). Legumes are much better Mg accumulators than grasses and almost no hypomagnesaemia or tetany has been reported to occur on legume pastures. Greater utilization of legumes in a grazing system is a good way to increase forage Mg content and reduce the danger of hypomagnesaemia inherent in all-grass pastures. Within the group of common cool-season grasses, there are only minor differences in Mg content with the exception of tall fescue, which is usually slightly higher in Mg than the other grass species.

## DISCUSSION

Grass tetany has not been a major problem in Ohio in the past several years. However, this does not imply that the situation will remain the same indefinitely or even over a short term. The incidence may vary with localities, season, and agronomic and livestock management practices. The severity of grass tetany appears to be closely related to environmental conditions and is thus subject to seasonal variations.

An increasing awareness by farmers of possible soil and forage Mg deficiences and the associated tetany problem and adoption of the recommended preventive practices may also be factors in the reduced number of reported cases. The use of salt-magnesium oxide mixtures to supplement animal Mg uptake has become more widespread and has had a positive effect in reducing tetany occurring on hay or silage. It is likely that this procedure will continue to be the primary preventive practice for winter tetany for some time to come.

Prevention of spring tetany occurring on succulent spring grass by salt:MgO supplementation has not been completely successful or reliable. The animals may not consume enough of the mixture each day when turned out to pasture to meet their Mg requirements during this critical time. The most economical, long-term solution to this form of tetany is to increase the soil Mg levels through the use of high magnesium limestone. By using a high magnesium limestone, when lime is called for by soil test, soil Mg content can be gradually increased to an adequate level (15% Mg base saturation). Liming will not provide any immediate benefit since the Mg will only be gradually released into the soil over a period of years. On a short-term basis, probably the most successful method of preventing or substantially reducing spring tetany has been to dust pastures with MgO. An application of 25 to 30 lb. per acre when the grass has reached a height of 3 to 4 inches has been a very effective preventive measure lasting several weeks (5).

When tetany cases occur, it is important that the animal be treated promptly with magnesium and usually calcium injections. It is also advisable to have the veterinarian collect blood samples immediately prior to treatment and submit the samples for mineral analyses in order to help establish an accurate diagnosis. It is advisable to force feed 2 oz. of MgO daily to any treated cow for 2 weeks to prevent relapses, and it is often advisable to immediately force daily MgO consumption to the high-risk animals in the herd. Daily intake of adequate magnesium must be emphasized throughout the high-risk period.

Plant analysis and ration evaluation services offered by The Ohio State University can be used to evaluate the Mg level of feeds fed to animals. Feed analysis coupled with complete soil tests (regular analysis plus base analysis) can serve as vital tools in improving and maintaining animal mineral nutrition.

The results of these studies during 1970 and 1971, while they did not yield any new information on the basic mechanism of the disease, have been useful in establishing the soil-plant-animal mineral interrelationships basic to the disease in Ohio. At present, much more is known about the external factors affecting the disease than about the basic mechanism responsible for triggering the disease in the animal. Much research is needed on the physiology of uptake and metabolism of Mg in the animal before the complex relationship between forage composition and hypomagnesaemia can be fully understood. When this information becomes available, a more direct approach can be made to overcome this disease at the plant and animal level.

## SUMMARY

A survey of grass tetany cases in southeastern Ohio in spring 1970 and spring 1971 indicated that soils with Mg saturation values of less than 15% and those high in K were most tetany prone. Most spring tetany also occurred within a short time after the animals were put on pasture. The forage Mg content in grass tetany cases was always less than 0.2% and usually ranged from 0.12 to 0.16% Mg.

Although tetany was not induced in grazing studies carried out in spring 1970 and spring 1971, the depressing effect of young grass on blood serum Mg was very evident. Several animals became severely hypomagnesaemic but did not exhibit clinical tetany symptoms. Low blood serum Mg is not a reliable indicator for the imminence of tetany, but is a useful tool for confirming a diagnosis after symptoms have occurred.

Nitrogen fertilization of grasses results in increased plant N, Mg, and K concentrations. Higher levels of both N and K have been associated with increased incidence of tetany. Plant Mg concentration is highest in the earliest stages of growth. Most common cool-season grasses have similar Mg content with the exception of tall fescue, which is somewhat higher in Mg. Legumes are much better accumulators of Mg than grasses are and provide one way of improving the Mg supply of pastures or hay.

Grass tetany has not been a severe problem in Ohio for the past several years. An increasing awareness by farmers of potential soil and plant Mg deficiencies has led to the adoption of recommended preventive practices. These practices include use of high Mg limestone for liming and feeding supplemental Mg via a salt:MgO mixture. Research is continuing on this complicated disease and hopefully a better understanding will be achieved, leading to a long-term solution to this problem.

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