PUBLICATIONS
1985

Forage Research In Texas, 1985

Clover Establishment and Growth at Different pH Levels

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Summary

Arrowleaf, berseem, crimson, rose, subterranean, white clovers, and alfalfa were grown at a pH of 4, 5, 6, 7, and 8. Potting material was a coarse sand that was washed with a 1.0 nitrogen (N) hydrochloric acid solution. Nutrient solutions were adjusted with sodium hydroxide or sulfuric acid to the desired pH level. Data recorded were time interval from planting to seedling emergence, seedling survival, and dry weight per pot. Alfalfa required a pH of 6 or higher with optimum growth at pH 7 and 8. Arrowleaf was the most sensitive clover to pH with optimum establishment and growth at pH of 6. A minimum pH of 6 was required by rose and white clovers. Berseem, crimson, and subterranean clovers were the most tolerant of pH with poor survival and growth at pH of 4 only.

KEYWORDS: Clover/soil pH/clover establishment.

Introduction

Soil pH is critical for plant growth because it determines nutrient availability and uptake by plants. Plant species vary in their ability to extract nutrients and grow at different pH levels. Some plant species may be soil pH specific for optimum growth while others do well over a wide pH range. Clovers are being used more in pastures in the southeastern United States because they extend the grazing season, provide the highest quality forage, and add nitrogen to the soil. Information is lacking on the effect of soil pH on growth of clover species used in the southeastern United States. A greenhouse study was conducted at the Angleton Research Station to examine the effect of pH on the growth of major forage legume species.

Procedure

The study began February 9, 1984. Coarse sand was washed with a 1.0 nitrogen (N) hydrochloric acid solution to remove all carbonates from the potting material. This resulted in an inert potting material so that the pH levels could be maintained by adjusting the nutrient solution to the desired pH levels. Twenty to 25 seeds per pot were planted of Yuchi arrowleaf, Bigbee berseem, Dixie crimson, La. S-1 white, Mt. Barker subterranean, Kondinin rose clovers, and Florida 77 alfalfa. Each species was inoculated with their respective *Rhizobium* bacteria before planting using the Pelinoc-Pelgel system. All pots were watered once or twice daily to keep the potting material moist. The pH of the nutrient solutions were checked every day and were adjusted with 0.5 nitrogen sodium hydroxide or 0.5 nitrogen sulfuric acid to a pH of 4, 5, 6, 7, or 8. Because of the daily watering, the *Rhizobium* bacteria were washed out of the sand which resulted in very poor nodulation. Therefore, nitrogen was added to the nutrient solutions beginning March 1. Pots with more than 12 seedlings were thinned to 12 per plot. Data recorded were emergence of first seedlings, number of surviving seedlings, and plant dry weight per pot. The study was terminated April 9, 1984.

Results

The number of days between planting and emergence of first seedling is reported in Table 1. Alfalfa was the most sensitive legume species with no seedlings emerging at a pH of 4 and 5. Emergence of arrowleaf clover was twice as fast at a pH of 6 and 7 than the other pH levels. A pH of 4 delayed emergence of white and rose clover. Emergence of berseem, crimson, and subterranean clovers appear to be unaffected by pH.

Seedlings in about one-third of the pots needed to be thinned to 12. Alfalfa had an excellent stand at the three highest pH levels (Table 2). The best arrowleaf stand was at pH 6 with fair stands at pH or 7 and 8. A pH of 4 and 5 drastically reduced the seedling survival of arrowleaf, white and rose clover. Survival of other clovers was only reduced at a pH of 4.

TABLE 1. EFFECT OF pH ON THE NUMBER OF DAYS FROM PLANTING TO EMERGENCE OF FIRST CLOVER SEEDLING OF VARIOUS CLOVER SPECIES

	pH				
Clover	4	5	6	7	8
	Days				
Alfalfa	—	—	4	4	4
Arrowleaf	16	16	8	9	17
Berseem	6	4	4	4	4
Crimson	6	5	4	4	5
Subterranean	5	5	5	5	5
Rose	32	5	5	7	5
White	21	9	6	7	6

TABLE 2. EFFECT OF pH ON CLOVER SEEDLING EMERGENCE AND SURVIVAL

	pH				
Clover	4	5	6	7	8
	Seedlings/Pot				
Alfalfa	0	0	12.0	12.0	12.0
Arrowleaf	2.3	2.7	10.7	6.0	6.7
Berseem	8.3	12.0	12.0	11.0	12.0
Crimson	5.7	11.0	12.0	11.0	12.0
Subterranean	7.3	12.0	12.0	12.0	12.0
Rose	0.7	3.3	9.7	8.0	7.3
White	1.7	2.0	11.0	10.0	12.0

The dry weight of clover per pot is reported in Table 3. Alfalfa growth was best at pH of 7 and 8 although seedling stands were the same at the three highest pH treatments. Optimum arrowleaf and white clover growth was at a pH of 6 with moderate growth at a higher pH and very little growth at a lower pH level. Rose clover did best at the highest pH levels with growth decreasing as the pH decreased. Maximum berseem growth was at a pH of 7. Crimson and subterranean clover did well at all pH levels except 4.

Discussion

There was a wide variation in response of the different forage legumes to pH. Alfalfa required a pH of 6 or higher for seedling survival with optimum growth at pH 7 and 8. It appears that raising the soil pH from 6 to 7 or higher with lime would be profitable on alfalfa. Arrowleaf and white clover were the most sensitive clovers to pH as demonstrated by the dramatic increase in growth from a pH of 5 to 6. However, in contrast with the other clovers, growth was reduced at a higher pH. The delayed emergence and poor seedling survival of arrowleaf at the pH 4 and 5 may be a factor in the sometimes poor reseeding of this clover in the fall. A pH of 6 is essential for satisfactory production of both clovers.

Although berseem clover grew at all pH levels, the best performance was a pH 7. Crimson and subterranean clovers are adapted to the widest pH range with poor performance only at the pH 4 level. Rose clover would require a pH of 7 or higher for satisfactory yields.

Effect of pH on Rhizobium survival and nodulation could not be determined because of the daily flushing of the pots with nutrient solution. Nitrogen was not a

TABLE 3. EFFECT OF pH ON WEIGHT OF CLOVER

Clover	pH				
	4	5	6	7	8
	Grams/Pot				
Alfalfa	0	0	2.3	3.3	3.7
Arrowleaf	0.3	0.3	3.0	2.0	1.5
Berseem	1.2	1.7	2.0	2.3	1.2
Crimson	1.7	3.7	3.7	3.3	4.0
Subterranean	0.5	2.6	2.6	2.6	3.0
Rose	0.7	1.3	2.0	2.7	2.7
White	0.3	0.5	1.7	1.5	1.3

limiting factor to clover growth since it was added to the nutrient solution 19 days after the study began. Under field conditions, the legume plant relies on the *Rhizobium* bacteria for nitrogen through the symbiotic relationship. Although the legume may be adapted to a particular pH level, the *Rhizobium* may not, which will result in poor plant growth because nitrogem is limiting.