Effect of pH on Germination of Three Grass Species

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Highlight: *Hydrogen-ion concentration (pH) affected the percent germination of weeping lovegrass, sand bluestem, and blue panic in laboratory tests. The latter two species exhibited the ability to germinate over a wide pH range but showed repressed germiantion at pH levels near neutrality. Tests using water of unknown pH may not provide a true indication of potential germination.*

Many factors influence the processes of germination and seedling establishment. One factor that has received little attention is the effect of hydrogen-ion concentration (pH). Soil pH was found to determine species distribution by affecting germination (Justice and Reece, 1954). A slightly acidic condition was found to be most favorable to germination of several forage crops (Promsy, 1911). Breazeale and LeClerc (1912) concluded that the depressant effect of acidity was greater on the germination than the subsequent growth of wheat. Salter and McIlvaine (1920) germinated seeds of

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alfalfa, corn, red clover, soybeans, and wheat on filter paper with solutions adjusted to pH values between 2 and 8. Values of 3 through 8 produced equal germination results for all five kinds of seeds. At pH 2, no alfalfa seeds germinated, and low percentages were recorded for the other species. However, they found that a solution with pH 4 did not exert a depressing effect on the germination of the seeds studied, but did depress growth. They concluded that the optimum solution for germination was somewhere above pH 3 and below pH 8.

Seeds of sunflower and tomato were germinated in solutions which had been adjusted in unit steps of pH 2 through 10 by adding citric acid and potassium hydroxide (Malhotra, 1930). Maximum germination was obtained at pH 6. Solutions of pH 2, 3, 8, 9, and 10 gave inferior rates of germination. Seeds of heather (*Calluna vulgaris*), subjected to unit intervals between pH 2 and 10 by using sulfuric acid and sodium hydroxide, expressed maximum germination at pH 4 (Poel, 1949).

Within species variation in germination response to pH is also evident. Bohmont and Legg (1953) reported that maximum germination of halogeton (*Halogeton glomeratus*) occurred at pH 4, while Jansen and Cronin (1953) reported that maximum germination for the same species occurred at pH 6. In addition, Bohmont and Legg received 72% germination at pH 9, while Jansen and Cronin reported a sharp drop in germination as pH increased and only 2% germination at pH 8 and 8.5.

Materials and Methods

Weeping lovegrass (*Eragrostis curvula* (Schrad.) Nees), sand bluestem (*Andropogon hallii* Hack. cv. Elida), and blue panic (*Panicum antidotale* Retz.) were selected for germination at various pH levels because they commonly grow on acidic, neutral, and basic soils, respectively. Florets that had been in storage for 18 months were reduced to caryopses, fractionated in a seed blower, and the heaviest fraction of caryopses saved. Each caryopsis was visually examined under a magnifier for soundness before germination.

The range of hydrogen-ion concentrations was established by adding hydrochloric acid or potassium hydroxide to distilled water. The pH levels of the solutions used were 2.5, 4.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 10.0, and 11.5. Petri dishes were used as germination containers. Two Whatman No. 3 filter papers were placed in the bottom of each petri dish. Six ml of a solution was added to each petri dish and 100 caryopses of a species were placed in the petri dish.

Table 1. Percent germination as affected by pH of the water used during germination.[1]

pH level	Species		
	Weeping lovegrass	Sand bluestem	Blue panic
2.5	0 b	27 c	0 d
4.0	88 a	48 b	66 b
5.5	86 a	59 a	66 b
6.0	85 a	59 a	66 b
6.5	85 a	54 ab	51 c
7.0	88 a	50 b	51 c
7.5	87 a	53 b	53 c
8.0	83 a	55 ab	69 ab
8.5	83 a	54 ab	74 a
10.0	88 a	53 b	71 ab
11.5	88 a	54 ab	73 a
Species means	78	51	58

[1] Means within a column followed by the same letters are not significantly different at the .05 level of probability.

Three replications of each species in each of the 11 pH solutions were established as a split-plot design within species as main plots and pH levels as split plots.

The petri dishes were covered and placed in a germinator programmed for 16 hours at 20° C and 8 hours at 30° C out of each 24 hours. They were exposed to light during the period of high temperature.

The Association of Official Seed Analysts (1970) defines germination as: "... the emergence and development from the seed embryo of those essential structures which, for the kind of seed in question, are indicative of the ability to produce a normal plant under favorable conditions." In this experiment, this stage was said to have been reached when both the root and the shoot had attained a length of 5 mm. The germinated seedlings were counted weekly for 4 weeks.

Results and Discussion

Each of the grasses tested showed a different response to pH during germination. Differences in mean percent germination for each species as affected by pH are presented in Table 1. No germination of weeping lovegrass occurred at pH 2.5, while germination was high at all other levels. The highest percent germination of sand bluestem was at the slightly acidic levels of pH 5.5 and 6.0. The lowest percent germination for this species occurred at pH 2.5. It was the only species that germinated at the highly acidic condition.

The highest percent germination for blue panic occurred at pH 8.0 to 11.5 (Table 1). The percent germination near neutrality were the lowest. Perhaps neutrality does not favor the synthesis or action of an enzyme necessary for germination.

Conclusions

The germination of some grasses is affected by pH; however, all species tested germinated well over a large range of pH levels. The critical level of basicity for germination of all species tested was over pH 11.5. The critical level of acidity for sand bluestem germination was under pH 2.5 and for weeping lovegrass and blue panic germination was under a pH of 4. The percent germination of sand bluestem and blue panic was somewhat lower near neutrality than under slightly acidic or basic conditions.

The rules for seed testing of the Association of Official Seed Analysts (1970) call for the use of "water" for moistening the germination substratum. The pH of water varies greatly; therefore, the use of water of unknown pH may not give a true indication of the seed's viability.

Many ions can be toxic at relatively low concentrations. Therefore, care must be taken in interpreting and comparing results when different chemicals are used to adjust pH levels.

The species tested responded differentially to varying pH of the germination substratum. It could be postulated that varieties of ecotypes within a species may also respond differentially. This may furnish another criterion for selection of plant materials.

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