EFFECT OF A HYDROPHILIC GEL ON GERMINATION OF WOODY LEGUME SEEDS

JANET C. HENDERSON[1] and DAVID L. HENSLEY

Department of Horticulture, Kansas State University
Manhattan, Kansas 66506

Abstract. Seeds of black locust (*Robinia pseudoacacia*), common honeylocust (*Gleditsia triacanthos*), and Kentucky coffeetree (*Gymnocladus dioica*) were coated with either an adhesive plus hydrophilic gel, an adhesive only, or neither (control). The seeds were then planted in sand in the greenhouse, and irrigated at either 3-, 6-, or 9-day intervals. Percent germination of black locust and common honeylocust seeds irrigated at 3-day intervals was significantly decreased with exposure to hydrophilic gel. Gel-coated Kentucky coffeetree seeds irrigated at 6-day intervals also had a significantly lower percent germination than those treated with adhesive alone, but germination of untreated Kentucky coffeetree seeds was not significantly different than that of adhesive- or gel-coated seeds. No other significant difference in germination percentage was observed. Seedling heights and dry weights were not affected by seed treatment; however, decreased moisture availability due to longer time periods between irrigations tended to delay emergence and reduced seedling vigor.

Seeds treated with the same coatings as above were planted in the field where there were no significant effects on germination as a result of seed coatings with any of the species.

INTRODUCTION

Hydrophilic gels are compounds which, according to manufacturers, improve seed germination and seedling survival. These materials absorb many times their weight in moisture and release it as the environment becomes dry.

Hydrophilic gels can be used as a seed coating, as a fluid drilling medium, or incorporated into a plant growing medium. Studies examining the effect of hydrophilic gel coatings on seed germination and seedling growth have produced conflicting results. Seeds coated with a hydrophilic gel, then planted in strip mine soil had a higher initial germination rate than untreated seeds (3). Similarly, hydrophilic polymer seed coating enhanced germination of sweet corn (*Zea mays*) at 2.3 and 4.6 g/kg seed but not at 9.1 g/kg seed, while all levels of polymer coating had a negative effect on germination of cowpea (*Vigna unguiculata*) (1). No improvement was evident in emergence rate or total germination of Russian wildrye (*Elymus junceus*) coated with five different hydrophilic coatings (2).

Germination of pepper (*Capsicum annuum*) seed coated with clay or sand decreased except when seeds were placed in a high oxygen environment, indicating that coatings may reduce 0_2 movement into the seed (5, 6). When high concentrations of hydrophilic

---

[1] Former Graduate Research Assistant. Present address: Dept. of Hort. Sci., Texas A & M University, College Station, Texas

materials were used as seed coatings, the water holding capacity was increased but aeration was apparently diminished (1). Reduced seedling vigor of pregerminated snapdragon (*Antirrhinum majus*) seeds stored in hydrophilic gels correlated also with decreased oxygen diffusion rates through the material (3).

Other factors may also contribute to reduced germination rates in the presence of hydrophilic gels. According to Searle (7), a hydrophilic material absorbed water and seeds germinated, but the soil was too hard for root penetration and seedling death resulted. In this situation, it would be advantageous for the seed to remain quiescent until adequate moisture was available to sustain growth and root penetration.

The purpose of the present study was to determine whether hydrophilic gel applied as a seed coating results in improved seed germination and seedling survival.

METHODS

Greenhouse studies. Seeds of black locust (*Robinia pseudoacacia*), common honeylocust (*Gleditsia triacanthos*), and Kentucky coffeetree (*Gymnocladus dioica*) were coated with hydrophilic gel (a starch-graft copolymer of potassium polyacrylate and polyacrylamide) after pregermination requirements were met. Seeds were weighed and dipped in an adhesive (maltodextrin and water 1:1 wt/wt) at rates of: a) 1% by seed weight; and b) the maximum amount retained by seeds when placed in excess gel-talc mixture. Other seeds were treated with only adhesive. Seeds were planted in 10 cm plastic pots of washed sand and irrigated at 3-, 6-, or 9-day intervals. Each treatment contained 15 seeds and was replicated three times in a completely randomized design.

Seedling emergence was evaluated and recorded daily. Germination was considered complete when no further seedling emergence was apparent for 7 days. Seedling heights and dry weights were measured 28 days after planting.

Arc-sin transformations (8) were performed on all germination data, and analysis of variance and mean separation procedures were conducted to evaluate differences among hydrophilic gel treatments within each species and irrigation interval.

Field studies. Seeds of the same deciduous hardwoods were treated as previously described and planted on May 23 in a prepared field of Haynie very fine sandy loam. Each treatment contained ten seeds and was replicated four times. The plots received no fertilizer or supplemental irrigation prior to or during the study. Post-planting precipitation was as follows: May, 0.16 in. (1 incidence); June, 3.39 in. (11 incidences); July, 0.55 in. (1 incidence); August, 1.07 in. (5 incidences). Weeds were removed by hand as necessary.

Seedling emergence was evaluated daily until apparently com-

plete. Above-ground portions of plants were harvested 42 days after planting and dry weights determined after drying for 48 hr at 80°C. Statistical analyses were the same as those described above.

RESULTS AND DISCUSSION

Greenhouse studies. Percent germination of black locust seed irrigated at 3-day intervals was significantly greater in untreated seeds than in seeds treated with hydrophilic gel (Table 1). This trend was also apparent with 9-day irrigation intervals, although differences were not significant.

Table 1. Influence of seed coatings and 3-, 6-, and 9-day irrigation intervals on seedling emergence, average height (cm) and dry weight (g) of black locust. Data were taken 28 days after first seedling emergence.

	Seedling emergence (%)			Height (cm)		Weight (g)	
Treatment	3 day	6 day	9 day	3 day	6 day	3 day	6 day
Control	99.2a[z]	43.0a	43.6a	4.6a	3.0a	.04a	.02a
Adhesive only	91.3ab	46.7a	31.1a	4.5a	3.6a	.04a	.04a
1% hydrogel	84.5b	51.5a	16.4a	4.3a	3.7a	.04a	.03a
Excess hydrogel	83.2b	44.4a	4.4a	4.3a	3.5a	.05a	.04a
Overall mean	89.6A[y]	46.4B	23.9C	4.4A	3.4B	.04A	.03B

[z] Mean separation using Tukey HSD (.05). Means within columns followed by the same lower case letter are not significantly different.
[y] Mean separation using Tukey HSD (.05). Means within measurement parameters followed by the same capital letter are not significantly different.

The tendency for decreased emergence of treated seeds may be attributed to a decrease in aeration around these seeds, as indicated by Sachs, Cantliffe, and Nell (5, 6) with coated pepper seeds. Oxygen availability to the seed may have been reduced by the adhesive material and further inhibited by the addition of the gel material, particularly at the higher gel rate. Baxter and Waters (1) found that polymers had a beneficial effect on imbibition and germination of sweet corn at high water potentials, but this was reversed as water potentials increased.

Black locust seedling heights and dry weights were not significantly affected by any of the seed treatments (Table 1). Apparently, once the seed germinated, seed coating had no detrimental or advantageous effect.

Average emergence and growth of black locust seedlings were affected by irrigation interval (Table 1). Seedling emergence was significantly decreased as time between irrigations increased from 3 to 6 days and from 6 to 9 days. As expected, seedling heights and dry weights were also significantly decreased by reduced watering. Nine days between irrigations provided inadequate moisture for black locust seedling survival.

Germination of common honeylocust in response to seed treatment differed from that of black locust. Percent emergence was not significantly different for any seed treatment in any irrigation regime (Table 2). Seedling heights and dry weights also showed no significant differences between treatments.

Table 2. Influence of seed coatings and 3-, 6-, and 9-day irrigation intervals on seedling emergence, average height (cm), and dry weight (g) of common honeylocust. Data were taken 28 days after first seedling emergence.

	Seedling emergence (%)			Height (cm)		Weight (g)	
Treatment	3 day	6 day	9 day	3 day	6 day	3 day	6 day
Control	64.4[z]	44.1	5.7	10.7	9.3	0.14	0.13
Adhesive only	60.3	62.3	8.3	11.6	8.6	0.16	0.13
1% hydrogel	73.8	56.2	3.0	11.1	8.3	0.16	0.10
Excess hydrogel	60.3	60.6	2.4	10.4	8.4	0.16	0.10
Overall mean	64.7A[y]	55.8A	4.9B	11.0A	8.6B	0.16A	0.12B

[z] There were no significant differences among treatments within each irrigation treatment in any measurement parameter (F-test, .05).
[y] Mean separation using Tukey HSD (.05). Overall means within measurement parameters followed by the same capital letter are not significantly different.

As with black locust, decreased irrigation frequency delayed seedling emergence of common honeylocust, although the delay was not significant until exposed to 9 days between irrigations (Table 2). Seedling heights and dry weights were significantly decreased with longer intervals between water applications. Inadequate moisture was available for honeylocust survival with 9-day irrigation intervals.

Percent emergence of Kentucky coffeetree seed followed no consistent trends in any irrigation regime (Table 3). Hydrophilic gel-

Table 3. Influence of seed coatings and 3-, 6-, and 9-day irrigation intervals on seedling emergence, average height (cm), and dry weight (g) of Kentucky coffeetree. Data were taken 28 days after first seedling emergence.

	Seedling emergence (%)			Height (cm)			Weight (g)		
Treatment	3 day	6 day	9 day	3 day	6 day	9 day	3 day	6 day	9 day
Control	95.6a[z]	89.1ab	64.6a	10.2a	10.5a	9.8a	0.8a	0.29a	0.25a
Adhesive only	93.4a	91.3a	94.9a	10.6a	10.8a	10.8a	0.51a	0.33a	0.33a
Excess hydrogel	98.5a	78.2b	91.3a	10.2a	10.8a	10.8a	0.49a	0.33a	0.34a
Overall mean	96.1 A[y]	86.2A	83.6A	10.3A	10.7A	10.5A	0.49A	0.32B	0.31B

[z] Mean separation using Tukey HSD (.05). Means within columns followed by the same lower case letter are not significantly different.
[y] Mean separation using Tukey HSD (.05). Means within measurement parameters followed by the same capital letter are not significantly different.

coated seeds at 6-day irrigation intervals had a significantly lower percent germination than seeds treated only with adhesive, but percent emergence of untreated seeds was not different than gel- or adhesive-treated seeds. As in other species, Kentucky coffeetree seedling heights and dry weights did not significantly differ among treatments within an irrigation interval (Table 3).

In contrast to other species, no significant differences in percent emergence of Kentucky coffeetree seeds occurred among irrigation regimes. Seedling heights also did not differ among irrigation schedules; however, dry weights of plants irrigated at 3-day intervals were significantly greater than those irrigated at 6- or 9-day intervals.

Seed size appeared to have an effect on seedling ability to survive low moisture levels (Table 4). Black locust, a small seeded species, was less tolerant to lower moisture levels than common honeylocust, a species with larger seeds. Kentucky coffeetree, a species with very large seeds survived all irrigation regimes tested. Therefore, larger seeds may retain higher moisture levels and better support seedling growth and development for a limited time after germination.

Table 4. Average percent emergence of seeds of 3 woody species exposed to 3-, 6-, or 9-day irrigation intervals.

	Irrigation interval (day)		
Species	3	6	9
Black locust	89.6a	46.4b	23.9c
Common honeylocust	64.7a	55.8a	4.9b
Kentucky coffeetree	96.1a	86.2a	83.6a

[z] Mean separation using Tukey HSD (.05). Means within species followed by the same letter are not significantly different.

Field studies. There were no significant differences in seed germination of any of the species tested due to treatment (Table 5). There were also no significant differences between shoot dry weights among seed coatings of any species.

Table 5. Percent germination of seeds of three woody legumes when planted in the field after treatment coating with sticker and hydrogel. There were no statistical differences (F-test, .05) in germination due to seed treatments.

	Species		
Treatment	Honeylocust	Black locust	Kentucky coffeetree
Control	52.5	40.0	82.5
Sticker	62.5	52.5	82.5
1% hydrogel	67.5	32.5	—
Excess hydrogel	60.0	27.5	67.5

SUMMARY

These studies indicate that hydrophilic gels utilized as seed coatings do not consistently or significantly improve seed emergence or subsequent seedling vigor of the plants tested. They may, in fact, inhibit or delay emergence by reducing aeration around the imbibing or germinating seed.

LITERATURE CITED

1. *Baxter, L. and L. Waters, Jr. 1986. Effect of a hydrophilic polymer seed coating on the field and laboratory performance of sweet corn (Zea mays L.) and cowpea (Vigna unguiculata (L.) Walp.) Jour. Amer. Soc. Hort. Sci.* 111:31–34.
2. Berdahl, J. D. and R. E. Barker. 1980. Germination and emergence of Russian *wildrye seeds coated with hydrophilic materials. Agron Jour. 72:1006–1008.*
3. Frazier, D. C., S. C. Wiest and R. D. Wootton 1982. Storage of pregerminated seed of snapdragon (*Antirrhinum majus* L.) in hydrophilic gels. *Jour. Amer. Soc. Hort. Sci.* 107:660–664.
4. Rodgers, C. S. and R. C. Anderson. 1981. Prairie grass response to strip mine spoil amended with sewage sludge. *Bull. Ecol. Soc. Amer.* 62:243. (Abstr.).
5. Sachs, M., D. J. Cantliffe and T. A. Nell. 1982. Germination behavior of sand-coated sweet pepper seed. *Jour. Amer. Soc. Hort. Sci.* 107:412–416.
6. Sachs, M., D. J. Cantliffe and T. A. Nell. 1981. Germination studies of clay-coated sweet pepper seeds. *Jour. Amer. Soc. Hort. Sci.* 106:385–389.
7. Searle, L. 1977. New seed treatment attracts soil moisture. *Soybean Digest. 37(7):28–30.*
8. Steel, R. and J. Torrie. 1960. Principles and Procedures of Statistics. McGraw-Hill, New York.