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Factors affecting seed germination, seedling emergence, and survival of texasweed (*Caperonia palustris*)

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Field, laboratory, and greenhouse experiments were conducted to determine the seed production potential and effect of environmental factors on germination, emergence, and survival of texasweed. Texasweed produced an average of 893 seed per plant, and 90% were viable. Seed exhibited dormancy, and prechilling did not release dormancy. Percent germination ranged from 56% for seed subjected to no prechilling to 1% for seed prechilled at 5 C for 140 d. Seed remained viable during extended prechilling conditions, with 80% of seed viable after 140 d of prechilling. Texasweed seed germinated over a range of 20 to 40 C, with optimum germination (54%) occurring with a fluctuating 40/30 C temperature regime. Seed germinated with fluctuating 12-h light/dark and constant dark conditions. Texasweed seed germinated over a broad range of pH, osmotic potential, and salt concentrations. Seed germination was 31 to 62% over a pH range from 4 to 10. Germination of texasweed ranged from 9 to 56% as osmotic potential decreased from − 0.8 MPa to 0 (distilled water). Germination was greater than 52% at less than 40 mM NaCl concentrations and lowest (27%) at 160 mM NaCl. Texasweed seedlings emerged from soil depths as deep as 7.5 cm (7% emergence), but emergence was > 67% for seed placed on the soil surface or at a 1-cm depth. Texasweed seed did not germinate under saturated or flooded conditions, but seed survived flooding and germinated (23 to 25%) after flood removal. Texasweed seedlings 2.5 to 15 cm tall were not affected by emersion in 10-cm-deep flood for up to 14 d. These results suggest that texasweed seed is capable of germinating and surviving in a variety of climatic and edaphic conditions, and that flooding is not a viable management option for emerged plants of texasweed.

Nomenclature: Texasweed, *Caperonia palustris* (L.) St. Hil. CNPPA.

Key words: Flooding, osmotic potential, photoperiod, seed dormancy, temperature.

Texasweed is a dicotyledonous summer annual and a member of the family Euphorbiaceae. It is an erect herb ranging in height from 30 to 300 cm (SWSS 1998). Cotyledons are smooth, and stems and petioles are coarsely pubescent. Leaves are 3 to 15 cm long, alternate, broadly lanceolate, and serrated on the margins. Seed are dark brown, 2.5 mm in diameter, and minutely pitted. In recent years, texasweed has become a problem weed in rice (*Oryza sativa* L.) and soybean [*Glycine max* (L.) Merr] grown in the lower Mississippi River Delta Region. It is difficult to control with glyphosate and other herbicides. Griffin et al. (2002) reported limited control with various rates and combinations of glyphosate, acifluorfen, bentazon, and fomesafen when plants exceeded the three-leaf growth stage. Infestations are currently restricted to only a few Mississippi Delta counties, but the difficult-to-control nature of this weed raises great concern about potential spread into other areas. In addition, seed production appears to occur for an extended period of time throughout the growing season, with mature seed dehiscing while new seed are being produced (C. H. Koger, unpublished data).

Texasweed prevails in fields with clay soils, which are commonly used for rice and soybean rotation systems. It appears to be more problematic in soybean planted in May or later during years with dry springs (A. Blaine, personal communication). Under such conditions, texasweed and soybean planted into warm soils tend to germinate at the same time after rainfall events and soybean may not have sufficient time to establish a competitive advantage. In contrast, texasweed appears to be less problematic in earlier planted (March–April) soybean, with populations often occurring in tractor wheel tracks and between rows in soybean grown in wide rows, suggesting that light may be a requirement for germination and that shading may suppress emergence (D. Poston, unpublished data). Texasweed tends to be a sporadic problem in Louisiana rice fields, where it has been observed to be a problem in a field one year and barely present the next year (E. P. Webster, personal communication). These field observations suggest that texasweed emergence and growth may be greatly influenced by environmental factors such as soil temperature, available moisture, and shading.

Environmental factors such as temperature, light, pH, and soil moisture are known to affect seed germination (Chachalis and Reddy 2000; Taylorson 1987). Burial depth of seed also affects seed germination and seedling emergence. Weed seedlings may emerge from the soil surface to 15 cm deep (Bello et al. 2000; Reddy and Singh 1992; Shaw et al. 1991; Singh and Achhireddy 1984). Information about texasweed germination is lacking. Little is also known about the effects of environmental and edaphic conditions common to soybean and rice production systems of the low-

er Mississippi River Valley Region on texasweed seed germination and seedling emergence and establishment. Information regarding seed production potential of texasweed is lacking. An understanding of texasweed seed germination and emergence will help predict ecological range and potential for spreading into new areas.

The objectives of this study were to (1) characterize texasweed seed production, (2) determine the effect of light, temperature, planting depth, pH, and osmotic and salt stress on seed germination, and (3) investigate effect of flooding depth and duration on seed germination and seedling survival.

Materials and Methods

Texasweed seed were harvested in the summer of 2001 from plants growing in a soybean field near Stoneville, MS (33°26′N, 90°61′W). To obtain enough seed for this research and to determine the effects of intraspecific competition on seed production, seed were planted 1 cm deep in the center 1-m^2 area of 5- by 5-m plots in early May of 2002 in a noncropped, conventionally tilled field at the Southern Weed Science Research Unit farm, Stoneville, MS. Emerged seedlings were thinned by hand to densities of 1, 2, 4, and 8 plants m^{-2}, and water-permeable plastic sheeting[1] was placed on the soil surface under the canopy of each plant so that mature seed could be collected after dehiscing. Before the first frost in 2002, plants were harvested and remaining seed on each plant were collected. Naturally dehisced and hand-harvested seed from each plant were counted and stored separately in screw-top transparent glass jars at room temperature (22 C) in the dark until used in experiments, which were initiated within 6 mo of collection.

Seed Production and Characterization

Seed from each plant (naturally dehisced and hand-harvested) were counted to estimate seed production potential. Only naturally dehisced seed were used in the experiments because hand-harvested seed were not allowed to naturally dehisce and may not have been fully mature at time of collection. Seed were classified by color as dark or light gray. For all experiments, only the predominant dark gray seed were used. The diameter of each seed was measured on 100 randomly selected seed per plant, and the total weight of 100 randomly selected seed per plant was recorded. Seed of all plants for all plant densities were pooled and mixed for use in all following experiments.

General Information

Twenty-five seed were placed between two layers of Whatman filter papers[2] in 9-cm plastic petri dishes. Filter papers were moistened with 7 ml of distilled water or test solution. Petri dishes were wrapped with parafilm[3] and then placed inside transparent self-sealed plastic bags to minimize water losses from evaporation. Germination was determined by visible radicle protrusion 2 wk after incubation. Germinated seed were removed from petri dishes, and nongerminated seed were left for another 2 wk, where no further germination was observed. Nongerminated seed were tested for viability using a 1% tetrazolium chloride test (ISTA 1985).

Temperature and Light

Germination was determined in growth chambers under constant (10, 20, 30, 40 C) or fluctuating day/night temperatures (20/10, 30/20, 40/30 C). Photoperiod was set at 12 h to coincide with the high-temperature period. Fluorescent lamps were used to produce a photosynthetic photon flux density of 200 $\mu mol\ m^{-2}\ s^{-1}$. A set of petri dishes was wrapped in a double layer of aluminum foil to study seed germination in the dark. Seed without prechilling were used in all experiments except in a prechilling study.

Prechilling

Seed were exposed to prechilling in attempts to break any dormancy mechanism imposed on seed kept at room temperature. Prechilling is described as the exposure of seed to cold and moist conditions for the required period (Bewley and Black 1982). Seed were placed between two layers of paper towels moistened with distilled water and then placed inside self-sealed plastic bags. Samples were subsequently stored in a refrigerator (5 ± 2 C) for 1, 7, 14, 28, 56, 84, and 140 d. Germination was determined after the prechilling period in all treatments. Germination tests were performed as described above. In all subsequent experiments, seed not exposed to prechilling were used because the highest germination percentage was achieved when seed were kept at room temperature vs. exposed to prechilling.

pH

Germination as affected by pH was studied using buffer solutions of pH 4 to 10 prepared as described for trumpetcreeper [*Campsis radicans* (L.) Seem. *ex* Bureau] seed (Chachalis and Reddy 2000). A 2 mM potassium hydrogen phthalate buffer solution was adjusted to pH 4 with 1 N HCl. A 2 mM solution of 2-(*N*-morpholine)ethanesulfonic acid was adjusted to pH 5 or 6 with 1 N NaOH. A 2 mM solution of *N*-(2-hydroxymethyl)piperazine-*N*′-(2-ethanesulfonic acid) was adjusted to pH 7 or 8 with 1 N NaOH. A pH 9 or 10 buffer was prepared with 2 mM tricine [*N*-tris(hydroxymethyl)methylglycine] and adjusted with 1 N NaOH. Unbuffered deionized water (pH 6.9) was used as a control. Petri dishes were incubated at 40/30 C day/night temperature with 12-h light because these conditions provided the highest percent germination according to the temperature and light experiment.

Osmotic and Salt Stress

Aqueous solutions with osmotic potential of 0, − 0.05, − 0.1, − 0.2, − 0.4, and − 0.8 MPa were prepared by dissolving appropriate amounts of polyethylene glycol 6000 in deionized water (Steuter et al. 1981). Petri dishes were incubated as described in the pH study.

Sodium chloride solutions of 0, 10, 20, 40, 80, and 160 mM were prepared. Petri dishes were incubated as described in the pH experiment.

Planting Depth

Twenty-five seed were planted in soil in 15-cm-diam plastic pots at depths of 0, 1, 2.5, 5, 7.5, and 10 cm. Soil used

for this and subsequent experiments was a Bosket sandy loam (fine-loamy, mixed, thermic Mollic Hapludalfs). Greenhouse temperatures were 40 ± 5 C during the day and 30 ± 3 C during the night. Natural light was supplemented with sodium vapor lamps to provide 12 h of light. Pots were watered as needed to maintain adequate soil moisture. Germinated seedlings were counted every 7 d for 30 d, with no seedling emergence observed after 21 d. Seedlings were considered emerged when the two cotyledons could be visually discerned and were removed after weekly counts.

Effect of Flooding on Germination

Twenty-five seed were planted 1 cm deep in soil in 11-cm-diam pots. Results of burial depth study indicated that maximum germination occurred when seed were buried to this depth. Three flooding levels were evaluated by placing pots inside clear plastic buckets and flooding to 0, 2.5, and 10 cm above the soil. These flood levels were maintained for 30 d by adding distilled water to the buckets as needed. Pots of the 0-cm flood level were flooded up to the soil surface so that the effects of saturated soil on germination could be investigated. Pots of all three flooding treatments were removed from buckets after 30 d of flooding and allowed to dry for 7 d. These pots and a nontreated check were subirrigated for 24 h followed by no irrigation for 96 h for a 30-d period. Greenhouse conditions were the same as for the burial depth experiment. Germination was estimated as described in the planting depth experiment.

Effect of Flooding on Survival

Twenty-five seed were planted 1 cm deep in soil in 11-cm-diam pots. Several plantings were done so that plants of different sizes could be flooded simultaneously. After emergence, plants were thinned to 1 plant per pot. Plants that were 2.5, 7.5, and 15 cm tall were flooded to 10 cm above the soil. At flooding, 2.5-, 7.5-, and 15-cm-tall plants were in the cotyledon, one-leaf, and four-leaf growth stage, respectively. Plants of each growth stage were removed after flooding for 1, 7, and 14 d. A nontreated control of no flooding was included for each growth stage. Plants were subirrigated as needed when not flooded. Aboveground biomass was clipped at the soil surface, and the fresh weight was recorded for each plant at 4 wk after flooding. Greenhouse conditions were the same as described above.

Statistical Analysis

Experiments were conducted in a randomized complete block design except the flood survival experiment. The flooding on survival experiment was conducted as a split plot, with plant growth stage at time of flooding as the main plot and flood duration as the subplot. Treatments of each experiment were replicated four times, and each experiment was repeated. Data represent the average of the two experiments because no experiment by treatment interaction occurred. Data for seed production and characterization, temperature and light, prechilling, salt stress, and flooding experiments were subjected to an analysis of variance (ANOVA) using the general linear models procedure in SAS (SAS 1998). Means were separated using Fisher's Protected LSD test at $P = 0.05$. Regression analysis was more appropriate for data from the pH, osmotic stress, and planting depth experiments. Data from the pH and planting depth experiments were best fit to quadratic polynomial equations, whereas data from the osmotic stress experiment was best fit to a linear equation. Pseudo R^2 values were calculated to assess the goodness of fit for the appropriate equation. The R^2 value was obtained by subtracting the ratio of the residual sum of squares to the corrected total sum of squares from one. The residual sum of squares was attributed to that variation not explained by the fitted line. The R^2 and residual mean squares were used to determine the goodness of fit to the regression model. Percent germination data for all experiments were transformed using the $\log(x + 1)$ transformation, where x is percent germination. Transformation of data did not improve homogeneity; thus, ANOVA and regression analysis were performed on nontransformed percent germination.

TABLE 1. Effect of texasweed plant density on seed yield, diameter, and weight.[a]

Plant density	Seed yield	Seed diameter[a]	Seed weight[a]
plants m^{-2}	no. $plant^{-1}$	mm $seed^{-1}$	mg $seed^{-1}$
1	920	2.8	9.5
2	959	2.6	9.6
4	881	2.7	9.4
8	815	2.7	9.3
LSD (0.05)	NS[b]	NS	NS

[a] Average of 100 randomly selected seed per plant.
[b] Abbreviation: NS, not significant.

Results and Discussion

Seed Production and Characteristics

Texasweed produced an average of 893 ± 110 seed per plant (Table 1), and 90% of seed were viable (data not shown). There were no differences in seed production among the four texasweed densities. Intraspecies competition was not apparent at 1, 2, 4, and 8 plants m^{-2}. An average of 80% of naturally dehisced seed were dark gray compared with 20% being light gray. The average seed diameter was 2.7 mm. The average seed weight was 9.4 mg. No difference in seed production with increasing plant density suggests that this species may have extensive plasticity and that competition from other plants may not hinder its seed production potential.

Temperature and Light

Texasweed seed germinated with both a 12-h photoperiod and 24-h darkness; however, a 12-h photoperiod was more favorable than 24 h of darkness (Figure 1). At a constant temperature and a 12-h photoperiod, texasweed germination was highest at 30 C (50%), followed by 40 C (16%), 20 C (3%), and 0% at 10 C. When exposed to fluctuating temperatures, texasweed seed germination was highest at 40/30 C (54%), followed by 30/20 C (28%); there was no germination at 20/10 C (0%) under a 12-h photoperiod. A similar trend in germination with constant and fluctuating temperature regimens was observed in 24-h darkness. The temperature response of texasweed is similar to that reported

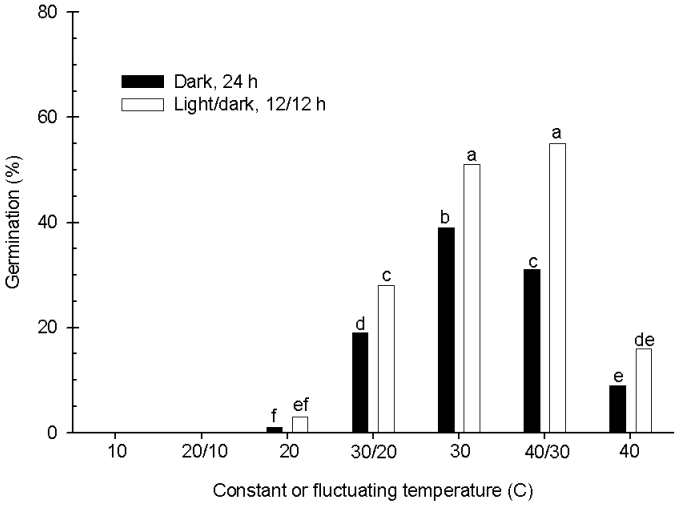

FIGURE 1. Effect of constant or fluctuating day/night temperature on germination of texasweed seed incubated in constant dark or a 12-h photoperiod for 2 wk. Bars with the same letters across all temperature by photoperiod combinations are not different ($P \geq 0.05$) according to $LSD_{0.05}$.

for other broadleaf weed species such as hairy beggarticks (*Bidens pilosa* L.) (Reddy and Singh 1992) and redvine [*Brunnichia ovata* (Walt.) Shinners] (Shaw et al. 1991). The optimum temperature reported for these weeds is 25 to 35 C.

Texasweed seed germinated in both light and dark conditions. Light requirement for germination varies depending on weed species. For example, hairy beggarticks seed germinate in light as well as in dark (Reddy and Singh 1992). Species such as bur beggarticks (*Bidens tripartita* L.), common lambsquarters (*Chenopodium album* L.), and common ragweed (*Ambrosia artemisiifolia* L.) require light for germination (J. M. Baskin and C. C. Baskin 1980; Benvenuti and Macchia 1997; Bouwmeester and Karssen 1993). The optimum temperatures for texasweed germination are similar to those of spring and summer temperatures in the southern United States. We observed that the date of first emergence for texasweed was May 12, 2002, and May 23, 2003, and emergence continued throughout the growing season at the USDA Southern Weed Science Research Unit farm, Stoneville, MS. Temperatures below a constant 20 C and at a fluctuating 20/10 C were not favorable for germination; consequently, spread of this weed may be restricted to warm regions. A high temperature (> 40 C) was not favorable for germination, but texasweed seed survived high temperatures that occur in the midsouthern United States.

Prechilling

A maximum of 56% of nonprechilled seed germinated at a fluctuating temperature of 40/30 C and 12-h photoperiod (Table 2). However, the tetrazolium chloride test indicated that most seed (> 97%) were viable. Therefore, we concluded that at least 41% of texasweed seed exhibit dormancy. Fifty-six percent of texasweed seed were able to germinate without any prechilling, whereas prechilling greatly reduced seed germination (Table 2). Prechilling for 1 d decreased texasweed seed germination to 17%, and seed prechilled for periods longer than 14 d germinated less than 4%. After 140 d of prechilling, 1% of seed germinated, and most seed (> 79%) were viable. Apparently, when texasweed seed mature in late summer they are innately dormant (primary dormancy). Seed in primary dormancy require moist chilling to come out of dormancy, and in nature, this occurs during winter (Egley and Duke 1985). It appeared that prechilling did not break the dormancy, and the prechilling results suggest that most texasweed seed would remain viable if exposed to cold and moist conditions for 140 d. Whether similar results will be obtained in soil under field conditions is not known.

TABLE 2. Effect of prechilling (moist, 5 ± 2 C) duration on germination of texasweed seed incubated at 40/30 C in a 12-h photoperiod for 2 wk.

Prechilling duration	Germination	Seed viability
d	%	
0	56	97
1	17	97
7	9	97
14	4	98
28	3	98
56	2	92
84	2	83
140	1	79
LSD (0.05)	8	11

pH

Texasweed seed germination followed a quadratic response to increasing pH ($y = -84.7 + 40.15x - 2.85x^2$, $R^2 = 0.91$), with increasing germination between pH 4 and 8 and decreasing germination at pH levels of 9 and 10 (Figure 2). Texasweed seed germination was greater than 42% over a pH range from 5 to 9. Seed germination was less than 32% at pH 4 and 10. These results are similar to those reported for redvine (Shaw et al. 1991), dogfennel [*Eupatorium capillifolium* (Lam.) Small], and yankeeweed [*Eupatorium compositifolium* Walt.] (Macdonald et al. 1992). In contrast, seed of milkweedvine (*Morrenia odorata* Lindl.) germinated best between pH 6 and 7.5 (Singh and Achhireddy 1984). High seed germination of texasweed over a

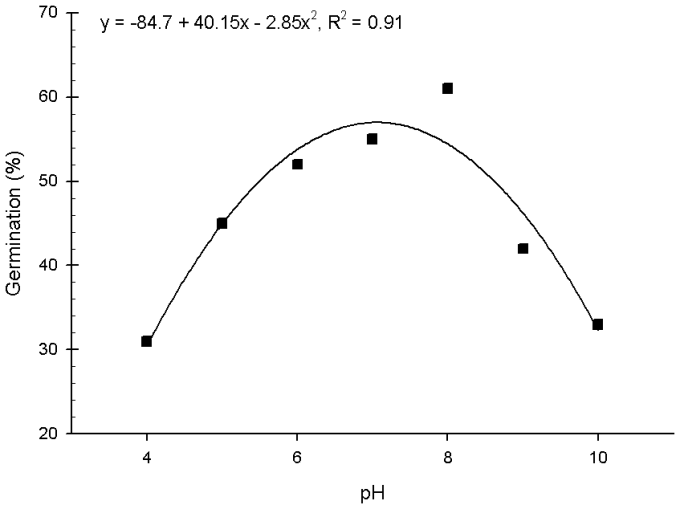

FIGURE 2. Effect of buffered pH solutions on germination of texasweed seed incubated at 40/30 C with a 12-h photoperiod for 2 wk.

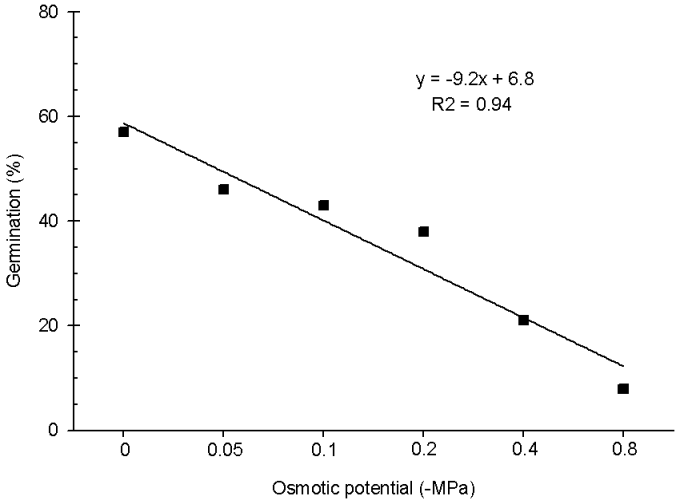

FIGURE 3. Effect of osmotic potential on germination of texasweed seed incubated at 40/30 C with a 12-h photoperiod for 2 wk.

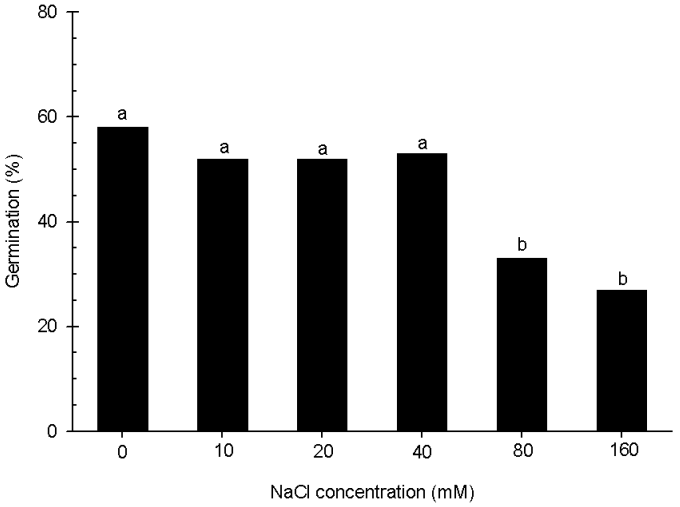

FIGURE 4. Effect of NaCl concentration on germination of texasweed seed incubated at 40/30 C with a 12-h photoperiod for 2 wk. Bars with the same letters across all temperature by photoperiod combinations are not different ($P \geq 0.05$) according to $LSD_{0.05}$.

broad pH range indicates that pH may not be a limiting factor for germination in most soils.

Osmotic and Salt Stress

Germination of texasweed decreased linearly ($y = -9.2x + 6.8$, $R^2 = 0.94$) as osmotic potential increased from 0 to −0.8 MPa (Figure 3). Nine percent germination at an osmotic potential of − 0.8 MPa indicates that texasweed can germinate under moderate water stress conditions, which are typical during the summer in the lower Mississippi River Delta Region. Similar to texasweed, some yankeeweed seed germinated (10%) at a water potential of − 0.8 MPa (Macdonald et al. 1992) and hairy beggarticks seed germinated (3%) at a water potential of − 0.75 MPa (Reddy and Singh 1992). However, weed species such as redvine (Shaw et al. 1991) and trumpetcreeper (Chachalis and Reddy 2000) were highly sensitive to low osmotic potential (less than − 0.2 MPa). Germination over a broad range of osmotic potential indicates that texasweed could pose a weed threat under low and high soil moisture conditions.

Texasweed seed germination was fairly sensitive to NaCl concentration (Figure 4). Germination was greater than 52% at less than 40 mM NaCl and was lowest (27%) at 160 mM NaCl. These data suggest that even at high soil salinity, texasweed seed may germinate.

Planting Depth

Emergence of texasweed seedlings decreased with increased planting depth ($y = 73.6 - 0.02x - 2.18x^2$, $R^2 = 0.95$), but seedlings emerged from all planting depths to 7.5 cm (Figure 5). Emergence was greater than 67% for seed placed on the soil surface or at a depth of 1 cm. No seedlings emerged from seed placed at a depth of 10 cm. These results agree with those of the temperature and light studies (Figure 1). Texasweed seed germinated under a 12-h photoperiod and 24-h darkness. Benvenuti (1995) reported that very little light (< 0.01%) is transmitted by any type of soil below a 4-mm depth. Texasweed seed do not require light to germinate, and 7% of seed germinated at a depth of 7.5 cm. These results suggest that under field conditions, notillage practices potentially would enhance texasweed emergence, whereas under conventional tillage practices, emergence will be more dependent on the effect that tillage has on the vertical distribution of seed in the soil. In contrast, redvine seed placed on the soil surface did not germinate (Shaw et al. 1991). Decreased emergence with increased planting depth has been reported in hairy beggarticks (Reddy and Singh 1992), redvine (Shaw et al. 1991), trumpetcreeper (Chachalis and Reddy 2000), and woolly cupgrass [*Eriochloa villosa* (Thunb.) Kunth] (Bello et al. 2000).

Effect of Flooding on Germination

Germination of texasweed was inhibited while soil was either constantly saturated or flooded up to 10 cm above the soil surface for 30 d (Table 3). No seedlings emerged during a 30-d saturated or flooded soil condition. However, some seed did germinate after the flood was removed. Per-

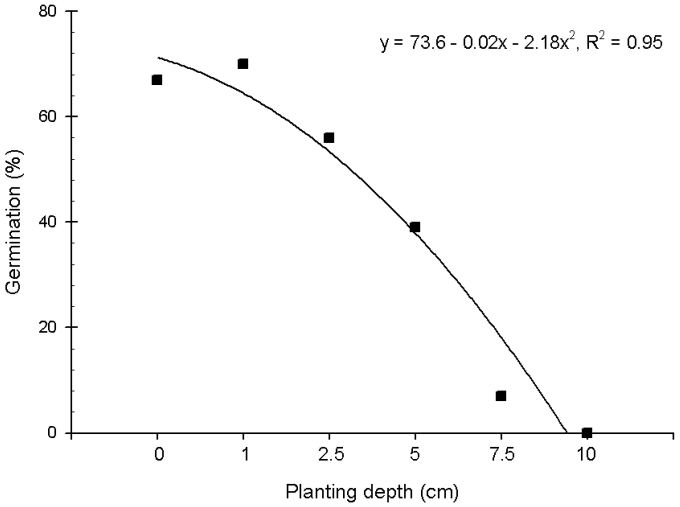

FIGURE 5. Effect of planting depth on germination of texasweed seed in a greenhouse maintained at 40/30 C (12/12 h) with a 12-h photoperiod for 4 wk.

TABLE 3. Effect of flooding on germination of texasweed seed.[a]

Treatment[b]	Germination	
	During flood[c]	After flood removal[d]
	%	
Soil saturation for 30 d[e], then 6 wet–dry cycles[f]	0	25
2.5-cm-deep flood for 30 d[g], then 6 wet–dry cycles[f]	0	24
10-cm-deep flood for 30 d[g], then 6 wet–dry cycles[f]	0	23
Control (6 wet–dry cycles[f])	—	64
LSD (0.05)	—	10

[a] Pots were maintained in a greenhouse at 40/30 C (12/12 h) with a 12-h photoperiod for 60 d.
[b] Pots of soil saturation and 2.5- and 10-cm-deep flooding treatments were placed inside larger buckets used to simulate flooding treatments. Control was not initiated until after the 30-d flood period.
[c] Percentage of seed that germinated during 30 d of flood.
[d] Percentage of seed that germinated during the 30-d wet–dry period after flood removal.
[e] Flood maintained at soil level.
[f] Each wet cycle consisted of 1-d subirrigation followed by 4 d of drying.
[g] Flood maintained to specified depth above soil level.

cent germination of texasweed seed subjected to 30 d of saturated or flooded soil followed by 30 d of six wetting–drying cycles such as that of the nontreated check (64% germination) was 23 to 25% across all three flooding treatments. Even though texasweed seed did not germinate in saturated or flooded soil, intermittent flooding does not appear to be a viable control option because seed germinated after flood removal.

Effect of Flooding on Survival

All texasweed plants, regardless of height at time of flooding, survived flood durations of 1 to 14 d (Table 4). Biomass of 2.5-cm tall plants was reduced with a 10-cm-deep flood maintained for 14 d when compared with the nontreated check (no flooding). However, biomass of 7.5- and 15-cm-tall plants was not different from the nontreated check across all flood durations. Flooding does not appear to be a viable management option for emerged plants of texasweed because flooding had little effect on plant biomass. More importantly, all plants survived an extended flood duration.

TABLE 4. Effect of duration of 10-cm-deep flood on dry weight of 2.5-, 7.5-, and 15-cm-tall texasweed seedlings.[a,b]

Flood duration[d]	Plant dry weight[c]		
	2.5 cm tall	7.5 cm tall	15 cm tall
d	g plant^{-1}		
0	2.1	1.8	2.7
1	1.6	1.7	2.8
7	1.2	1.6	2.9
14	0.8	1.4	2.7
LSD (0.05)	0.4	NS[e]	NS

[a] Pots were maintained in a greenhouse at 40/30 C (12/12 h) with a 12-h photoperiod.
[b] Plant height at time of flood initiation.
[c] Pots were placed inside larger buckets and flooded to 10 cm above the soil surface. Flood was removed after the indicated period, and pots were subirrigated as needed. Pots of the 0-d flood duration treatment were subirrigated as needed.
[d] Plants were clipped at soil surface at 30 d after flood initiation and dried at 40 C.
[e] Abbreviation: NS, not significant.

Therefore, texasweed should survive under flooded conditions used in rice production.

Texasweed germinates over a broad range of temperatures, environmental conditions, and under dark conditions, allowing for germination in dense, shaded areas such as under a crop canopy. Texasweed germinates under moderate water-deficit stress, which frequently occurs in crops such as soybean, and under moist soil conditions, which occurs in rice. Management options for emerged texasweed other than flooding must be considered because plants shorter and taller than a flood depth similar to that used in rice fields survived flooding with little to no effect on plant biomass.

Sources of Materials

[1] Weed X. Dalen products Inc., 11110 Gilbert Drive, Knoxville, TN 37932.
[2] Whatman #1, Fisher Scientific, 711 Forbes Avenue, Pittsburgh, PA 15219.
[3] Parafilm, American National Company, Greenwich, CT 06836.

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