
UNIVERSITY OF MISSOURI-COLUMBIA
COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
ELMER R. KIEHL, DIRECTOR

Morphological Development and
Germination of Lanceleaf Ragweed
(*Ambrosia bidentata*)

B. LEON MCINTYRE AND ELROY J. PETERS



(Publication authorized October 18, 1972)

COLUMBIA, MISSOURI

CONTENTS

Introduction	3
Materials and Methods	3
Morphological Studies	3
Germination Studies	4
Results and Discussion	5
Morphology of Lanceleaf Ragweed	5
Germination Study	13
Germination Inhibitor	17
Conclusions	17
Literature Cited	18

Morphological Development and Germination of Lanceleaf Ragweed (*Ambrosia bidentata*)

B. Leon McIntyre and Elroy J. Peters¹

INTRODUCTION

Lanceleaf ragweed (*Ambrosia bidentata* Michx.) is an annual weed commonly found in pastures and untilled areas from Louisiana to Minnesota, west to Nebraska, and south to Texas and Louisiana (6, 9). The southern two-thirds of Missouri, and the eastern quarter of Oklahoma and Kansas, and northern Arkansas are the most heavily infested. In Missouri alone, it is estimated that more than 5 million acres are infested with this weed.

Lanceleaf ragweed is undesirable because it competes with and reduces yields of desirable forage species and causes allergic reactions. Although it is relatively unpalatable, cattle occasionally will graze the tops to a limited extent.

This study was begun to acquire more complete information on lanceleaf ragweed, with the hope that an understanding of the biology of the weed may reveal ways of controlling it. Research objectives were: (1) to document the morphological development, and (2) to study the germination pattern of the achenes and the causes of achene dormancy.

MATERIALS AND METHODS

Morphological Studies

The plants for the morphological study were collected from a pasture southeast of Columbia. Lanceleaf ragweed plants were collected at various intervals for a period of two weeks late in August, 1966. Photographs were taken of the mature plant, the staminate head and its individual parts, and the pistillate flowers at various stages of achene development.

Seeds to be germinated for seedling identification were obtained April 10, 1967, by collecting three slices of soil 12 by 24 inches from the surface 4 inches of a pasture infested with lanceleaf ragweed. The soil was kept moist in the greenhouse and seedlings were identified by careful observation during the cotyledon stage until the first characteristic leaves appeared. Seeds of common ragweed (*Ambrosia artemisiifolia* L.) were also germinated. Pictures of the two ragweed species were taken at 2, 4, and 8 days after germination to document their appearance in order to simplify identification in early growth stages.

¹Formerly Graduate Assistant, Department of Agronomy, University of Missouri, Columbia, Missouri, and Research Agronomist, Agricultural Research Service, United States Department of Agriculture.

Germination Studies

The structure containing the seed of lanceleaf ragweed is properly called an achene because it is a simple, dry, one-seeded, indehiscent fruit, with the seed attached to the fruit wall at one place.

Achenes used in the germination studies were collected in October, 1967 and 1968, from plants in a pasture southeast of Columbia. Germination studies were begun in December of each year, and the last achenes were removed from the germination medium in March.

Before germination was attempted, the surface of the achenes was sterilized by a method similar to that described by Fendall and Carter (5). The achenes were immersed for 5 minutes in water containing 3% of the wetting agent alkyl-aryl-polyoxyethylene glycols (X-77). Achenes were then rinsed in distilled water, immersed in a 3% purex solution for 5 minutes, and rinsed thoroughly with distilled water.

Experiments were conducted to study the effects of scarification, steeping, gibberellic-acid treatment, fruit-wall removal, stratification, and inhibitors on germination of lanceleaf ragweed. All germination after treatment was in the dark at 80°F. This temperature was chosen because many achenes that failed to germinate at 40, 50, 60, or 70°F in other experiments did so at 80°F. Germinating achenes were counted at two-week intervals.

Scarification was performed by placing the achenes between two sheets of fine sandpaper and applying pressure to the top sheet while moving it in a circular fashion. Each circle completed was one cycle. The achenes were scarified for 10, 20, 30, or 40 cycles before placement on moist filter paper in petri dishes. The petri dishes were placed in a warm room (80°F) in the dark.

Steeping, a method used to wash away germination inhibitors, was accomplished by placing intact achenes in cheesecloth and running a small stream of tap water through the cloth for 48 hours. The achenes were then placed on moist filter paper in petri dishes and germinated in the dark at 80°F.

Effects of gibberellic acid were evaluated by soaking the achenes in gibberellic-acid solutions of 1, 10, 100, 1,000, and 10,000 ppm for 10 hours. The treated achenes then were rinsed in distilled water and placed in petri dishes for germination. Other achenes were scarified for 10, 20, 30, and 40 cycles and then soaked in the various gibberellic acid solutions before germination at 80°F.

To determine the effects of the fruit wall on germination, the fruit walls were removed by cutting through a ridge along the side of each achene, inserting the thumb nails into the slit, and cracking the fruit wall open to expose the seed. The excised seeds were then placed in petri dishes for germination at 80°F under artificial light.

The cold treatments were evaluated by putting dry intact achenes in refrigerators in December of each year at -10°, 0°, 20°, 30°, or 40°F. The control treatment in 1968 consisted of enclosing the achenes in small, fine-mesh-wire envelopes and then burying the envelopes in soil under tall fescue sod at a depth of 4 inches. The experiment was conducted without the control treatment in 1967,

due to a shortage of achenes. At intervals of two weeks, for a period of 16 weeks, four samples of 100 achenes were taken from each of the temperature treatments. The achenes were placed in germination medium at 40°, 50°, 60°, or 70°F for two weeks, and the number of seeds germinated was noted. Following this first period of germination, the achenes that did not germinate were exposed to a second period of germination at 80°F for two weeks.

To test the effects of germination inhibitors on lettuce seed, 84-g samples of lanceleaf ragweed achenes were extracted three ways:

(a) The sample was put into a metal pan with 200 ml of distilled water and brought to a boil. After it had cooled, the extract was poured off and stored at 40°F.

(b) A sample was ground in a Wiley mill using a 2-mm screen, mixed with 200 ml of distilled water, and allowed to stand 3 days at 40°F before it was used. The ground material was removed by filtering the mixture through a fine-mesh sieve.

(c) Two hundred ml of distilled water was added to a sample of intact achenes, and the sample was placed in a refrigerator at 40°F. The sample was allowed to stand at this temperature for 10 days. The extract was then poured off the achenes.

Lettuce seeds placed in petri dishes were used to test the three extracts for germination inhibitors. Four replicates of 100 seeds were used to test each of the three extracts and the distilled-water control. Filter paper placed above and below the lettuce seeds was moistened with extract. Seeds were then placed in direct sunlight at 85°F to germinate.

RESULTS AND DISCUSSION

Morphology of Lanceleaf Ragweed

Lanceleaf ragweed ranges from 6 to 36 inches tall, averages between 10 to 15 inches in height, and has short, long-pointed, hairy, lanceolate leaves (Figure 1). These lanceolate leaves bear one or two pairs of conspicuous sharp lobes or teeth at the broadened base. Most of the leaves point stiffly upward (4). The flowers are much reduced and monoecious. Female flowers are borne in the axils of the lower leaves, and the male flowers are borne above in a terminal spike.

In the field, lanceleaf ragweed achenes germinate late in March or early in April and the seedlings are often confused with common ragweed. Figure 2 shows the distinguishing characteristics of lanceleaf ragweed and common ragweed seedlings at 2, 4, and 8 days after emergence. Cotyledons of lanceleaf ragweeds are larger than those of common ragweeds, and the simple lanceolate bidentate leaves of lanceleaf ragweed are easily distinguished from the deeply lobed leaves of common ragweed.

Lanceleaf ragweed flowers from late July to early September. The staminate head bears small clusters of flowers which are hooded by hairy bracts (Figure 3). A cross section of the staminate head shows the arrangement of the bracts



Fig. 1—Mature lanceleaf ragweed plant taken from a pasture near Columbia, Mo., late in August.

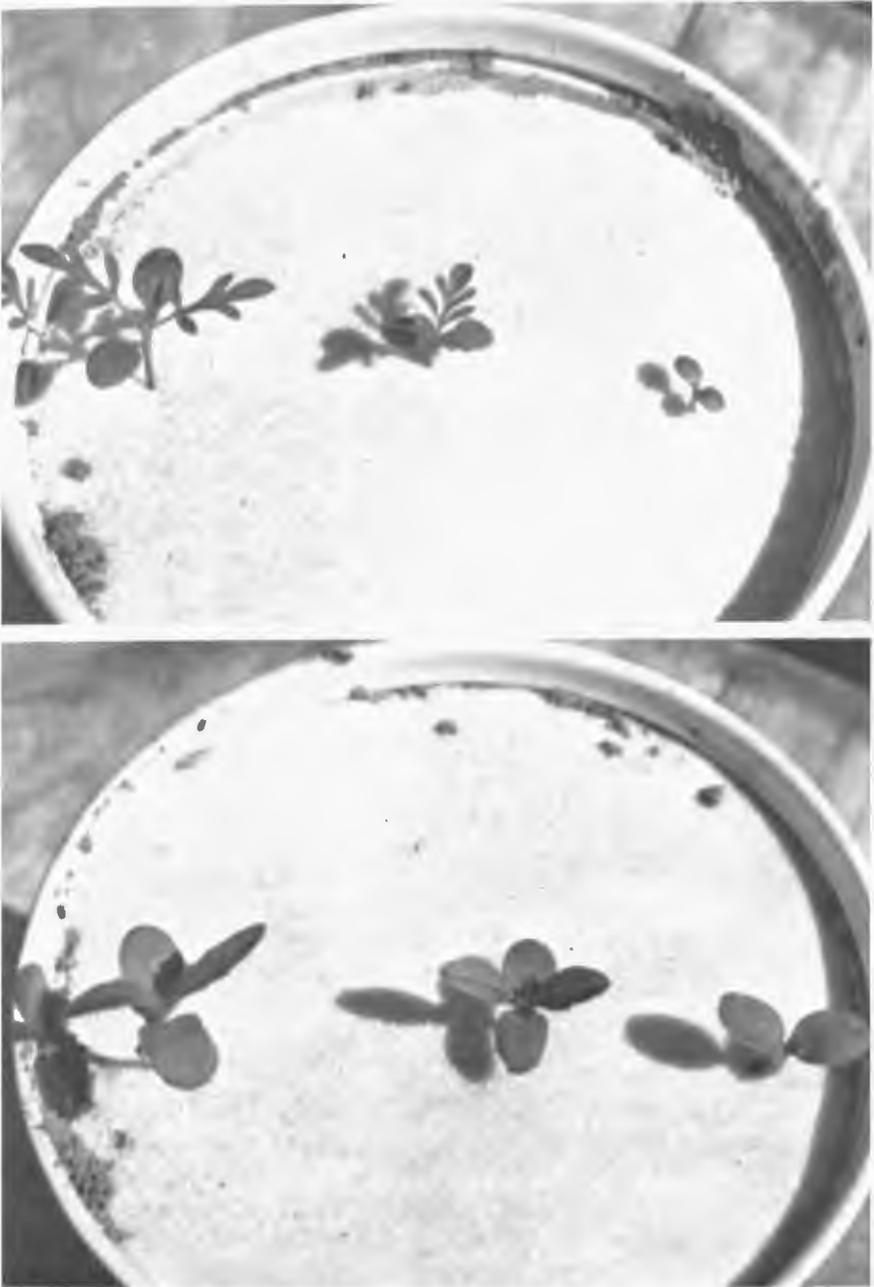


Fig. 2—Seedlings of common ragweed (*Ambrosia artemisiifolia* L.) (top), and lanceleaf ragweed (bottom) at 8, 4, and 2 days after emergence.

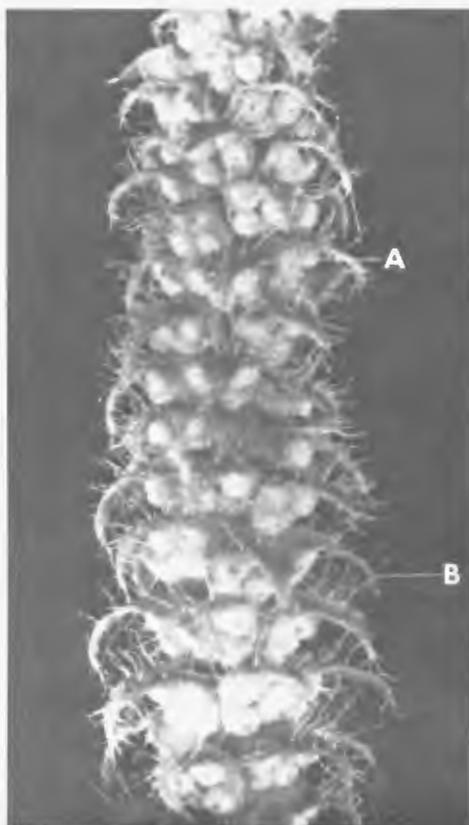


Fig. 3—A portion of the staminate head showing (A) the small cluster of staminate flowers and (B) the hooded, hairy bract.

and their individual flower clusters around the stem (Figure 4). When a flower cluster was stripped from the staminate head and photographed under low magnification, it revealed four staminate flowers, each individually surrounded by a corolla (Figure 5).

A magnification of a leaf below the staminate spike shows the typical hairy, lanceolate leaf with two conspicuous lobes or teeth and the immature achene of the female flower in the axil of the leaf (Figure 6). The female flower is surrounded by involucre bracts (Figure 7) and has a branched stigma. As the achene matures, the characteristic spines become prominent with obovoid shape, and only vestiges of the branched stigma remain on the central spine (Figure 8).



Fig. 4—A cross section of the staminate head of lanceleaf ragweed, showing the (A) bracts and (B) the flower clusters.

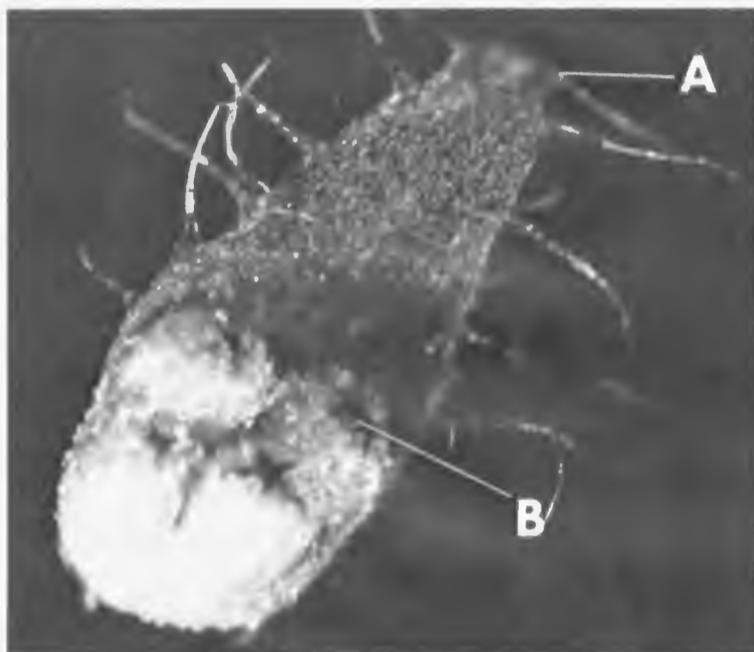


Fig. 5—Staminate flowers of lanceleaf ragweed in groups of four. Each flower cluster has (A) a bract. (B) A staminate flower.

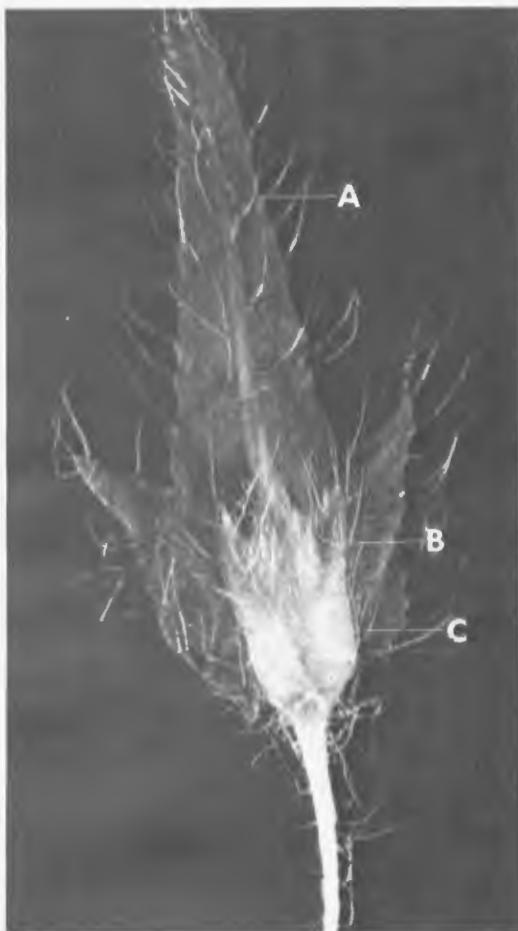


Fig. 6—Typical leaf of lanceleaf ragweed, showing (A) the typical lance-shape leaf with conspicuous teeth and (B) the immature achene surrounded by (C) the involucral bracts.

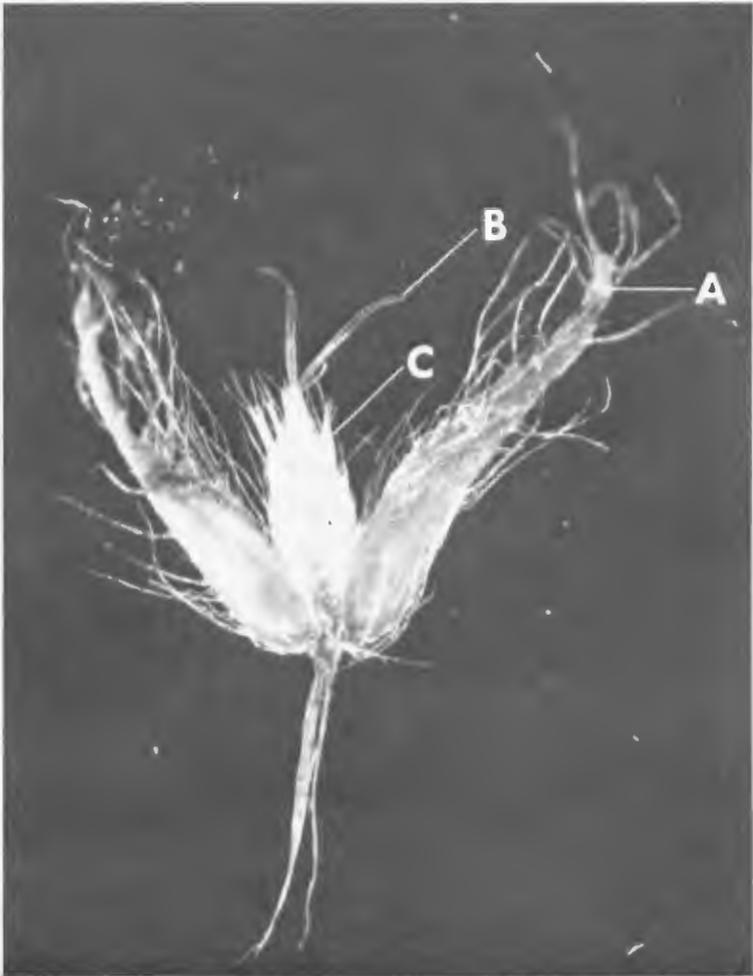


Fig. 7—Pistillate flower of lanceleaf ragweed, showing (A) bracts, (B) branched stigma, and (C) immature achene.

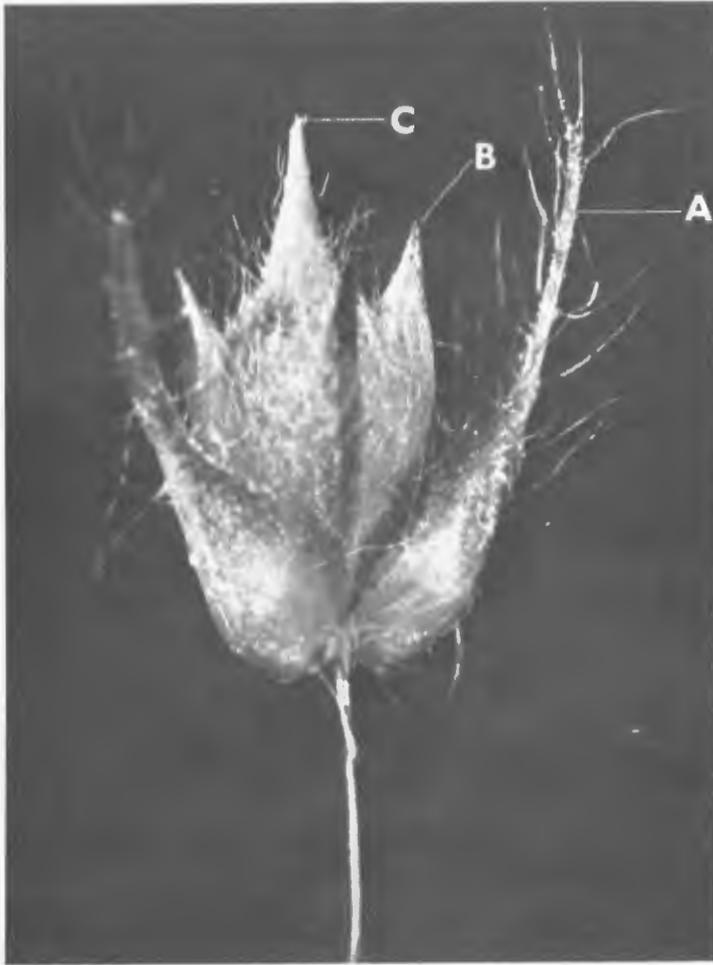


Fig. 8—Maturing pistillate flower, showing (A) bracts, (B) spines, and (C) vestiges of the branched stigma.

Germination Study

Scarification of the achenes with fine sandpaper for 10, 20, 30, and 40 cycles broke the seed coat sufficiently to admit moisture and allow gas exchange, but the achenes did not germinate. This indicates that impermeability of the seed coat is not a cause of dormancy.

None of the achenes could be induced to germinate after they had been steeped in running tap water for 48 hours. Apparently no readily leachable inhibitor is present within the achenes (7).

The achenes could not be induced to germinate at 80°F after they had been soaked in gibberellic-acid solutions of 1, 10, 100, 1,000, and 10,000 ppm for 10 hours. Gibberellic acid replaces the light requirement for some seeds and promotes germination in certain other seeds whose germination is not affected by light (7). This phytohormone had no effect on the achenes of lanceleaf ragweed, even after the seed coats were broken by scarification to allow gibberellic acid to penetrate.

Removing the fruit wall of the achene and exposing the seeds to moisture at 80°F did not promote germination. Evidently dormancy is not caused by mechanical restriction of the embryo by the fruit wall or by chemical inhibitors in the fruit wall (1, 3, 8).

Achenes that were buried in the soil, removed periodically, and placed under germinating conditions did not germinate until they had been buried for more than four weeks (Table 1). Germination began at six weeks, and the num-

Table 1. Percent germination of achenes after storage in soil for various periods and then germinated for 2 weeks at four temperatures.

Germination temperature (F.)	Weeks stored in soil								Av.
	2	4	6	8	10	12	14	16	
40°-----	0	0	8	25	37	48	32	42	24
50°-----	0	0	22	33	75	75	64	16	36
60°-----	0	0	7	8	28	49	55	0	18
70°-----	0	0	4	1	24	20	24	0	9
Av.-----	0	0	10	19	41	48	44	14	---

bers of achenes germinating increased thereafter. Fifty degrees appeared to be the most favorable temperature for germination, and 40° and 60° temperatures were slightly less favorable, but more favorable than 70°.

Table 2. Percent of ungerminated achenes from data in Table 1 that germinated at 80°F.

Germinating temperature (F.)	Weeks stored in soil								Av.
	2	4	6	8	10	12	14	16	
40°-----	3	19	57	57	58	40	71	0	38
50°-----	1	27	48	6	16	0	0	0	12
60°-----	0	0	0	0	0	0	0	0	0
70°-----	0	0	0	0	0	0	0	0	0
Av.-----		12	26	16	18	10	18	0	---

Achenes that did not germinate within two weeks after placement at 40°, 50°, 60°, and 70° were placed in germination medium at 80°. At 80° none of the achenes germinated when they had been previously exposed to 60° and 70°. Length of exposure to the soil appeared to be important for stimulating germination, because the percentage of seed that germinated was greater when achenes were stored in soil for six weeks than when they were stored for two to four weeks. Decline of germination during the 80° treatment of achenes that had been buried for more than six weeks and then exposed to 50° temperature is not a total decline because a large number of achenes had germinated before exposure to the 80° temperature. Total percentage germination after all exposures is given in Table 3.

The tendency for lower germination at 60° and 70° may be due to secondary dormancy induced by these higher temperatures. Davis (2) found that if

Table 3. Cumulative germination (in %) of all achenes after storage in soil, germination for 2 weeks at four temperatures, and finally germination at 80 degrees.

Germination temperature (F.)	Weeks stored in soil							
	2	4	6	8	10	12	14	16
40°-----	3	19	60	68	76	69	80	42
50°-----	1	27	59	37	79	75	64	16
60°-----	0	0	7	8	28	49	55	0
70°-----	0	0	4	1	24	20	24	0

the after-ripened embryos of giant ragweed (*Ambrosia trifida* L.) failed to germinate at high temperatures they would revert to a dormant state, and they must be again after-ripened before germination would take place. Furthermore, Mayer and Poljakoff-Mayber (7) mentioned that temperatures too high or too low for germination might also induce secondary dormancy in giant ragweed.

Dry achenes stored in refrigerators at a number of temperatures did not germinate when they were subsequently placed in germination medium at 60° and 70°. A very small number of these achenes broke dormancy when placed in germination medium at 40° and 50° (Table 4). None of the achenes removed

Table 4. Percent achenes germinating at 40 and 50 degrees after dry storage at various temperatures for various periods.

Storage temperature (F.)	Weeks in dry storage							
	2	4	6	8	10	12	14	16
	<u>Germinated at 40°</u>							
-10°-----0	0	0	0	0	0	0	0	0
0°-----0	0	0	0	0	1	0	0	0
10°-----0	0	1	1	2	1	1	0	0
20°-----0	0	0	0	0	0	0	0	0
30°-----0	0	0	1	0	1	1	0	0
40°-----0	0	1	2	2	2	3	6	6
	<u>Germinated at 50°</u>							
-10°-----0	0	0	0	0	0	0	0	0
0°-----0	0	0	0	0	1	0	0	0
10°-----0	0	1	1	3	2	2	0	0
20°-----0	0	0	0	0	0	0	0	0
30°-----0	0	0	1	0	2	2	0	0
40°-----0	0	0	4	3	4	5	12	12

from germinating temperatures of 60° and 70° and then placed at 80° broke dormancy. However, some of the achenes from the 40° and 50° germinating medium broke dormancy when placed at 80° (Table 5).

Table 5. Percent achenes germinating at 80 degrees after dry storage at various temperatures for various periods and germinated for 2 weeks at 40 and 50 degrees.

Temperature (F.)	Weeks in storage							Av.
	2	4	6	8	10	12	14	
<u>Germinated at 40°</u>								
-10°-----6	35	15	14	26	6	3	24	16
0°-----17	35	8	20	16	13	7	16	16
10°-----9	26	12	11	33	6	9	18	15
20°-----5	18	7	10	29	16	5	8	12
30°-----18	27	25	10	30	5	7	5	16
40°-----14	18	15	13	28	8	8	6	13
Av.-----11	26	13	13	27	9	6	12	
<u>Germinated at 50°</u>								
-10°-----4	14	3	9	6	11	8	9	8
0°-----3	13	6	8	10	8	5	8	8
10°-----2	9	25	17	42	6	11	9	15
20°-----2	15	16	9	13	10	9	9	11
30°-----3	7	12	22	9	3	12	4	9
40°-----5	15	5	14	22	7	8	5	10
Av.-----3	12	11	13	17	7	9	7	10

The percent of achenes that germinated was highly variable, and no significant statistical difference was found among the percentages that germinated. No more than 33 percent of the achenes germinated (Table 5) when initially exposed to varying temperatures under dry conditions, as compared with 75 percent germination when initially exposed to soil (Table 3).

These phenomena may be somewhat similar to those noted by Davis in giant ragweed (2). He noted that embryos of giant ragweed are dormant at maturity and after-ripen very slowly in dry storage, but after-ripen much more rapidly and completely in a saturated condition at 0° to 10°C. However, when we held achenes of lanceleaf ragweed in dry storage at 80° for one year, they could not be induced to germinate.

Table 6. Percent germination of lettuce seed moistened with three extracts of ragweed achenes.

Extract	Percent germination*
Water-----	82 a
Intact achenes-----	23 b
Ground achenes-----	9 b
Intact achenes, boiled-----	64 a

*Figures followed by the same letter are not significantly different according to Duncan's Multiple Range Test.

Germination Inhibitor

The test for the germination inhibitor shows that there is a water-soluble substance within the lanceleaf ragweed achenes that inhibits the germination of lettuce seeds. Extracts from the intact achenes and the ground achenes significantly inhibited germination of lettuce seed. Boiling destroyed the germination inhibitor. The extracts from the intact achenes and the ground achenes significantly inhibited the germination of the lettuce seed when compared to extracts from the boiled, intact achenes and the water. Whether the inhibitor that inhibits growth of lettuce seed is the same one that inhibits growth of ragweed achenes is not known.

The material that inhibits the growth of lanceleaf ragweed achenes apparently is not in the fruit wall of the achene, because removing the fruit wall did not induce germination of the ragweed achenes.

From the cold-temperature study it was shown that cold temperatures either alter or destroy the germination inhibitor in the achene and allow germination. However, it is also evident that the conditions present in the soil had a greater influence on breaking dormancy of the achenes than cold treatments alone. Soil conditions that break dormancy may be merely fluctuations in temperature and moisture, but other factors present in the soil also could be involved. Stratification was found to be the best means of removing the germination inhibitor from the achenes, and therefore, the most adequate treatment used to break the dormancy of lanceleaf ragweed achenes.

CONCLUSIONS

Ragweed achenes appear to have an after-ripening period, during which germination will not begin until more than six weeks have passed. There also

appears to be more prolonged dormancy in many achenes. Dormancy is not due to an impermeable seed coat because scarification, cracking, or removal of the seed coat did not increase germination.

Leaching with water for 48 hours did not increase germination. This indicates that inhibitors are not readily leached by water; however, water extracts of intact as well as ground achenes inhibit germination of lettuce seed. We did not determine whether this inhibitor from ragweed achenes inhibited germination of other ragweed achenes. Various concentrations of gibberellic acid applied to intact or scarified achenes did not affect germination.

Dry cold temperature did not increase ragweed germination. Moist soil, fluctuating temperature of the soil, and perhaps other influences of the soil during the winter were conducive to germination. There is also some evidence that temperatures over 60° may cause ragweed achenes to go into secondary dormancy.

LITERATURE CITED

1. Crocker, William. 1906. Role of seed coats in delayed germination. *Bot. Gaz.* 42:265-291.
2. Davis, W. E. 1930. Primary dormancy, after-ripening and the development of secondary dormancy in embryos of *Ambrosia trifida*. *Am. Jour. Bot.* 17:58-76.
3. Devlin, Robert M. 1966. *Plant Physiology*. Reinhold Publishing Corp., N.Y.).
4. Drew, W. B., and C. A. Helm. 1946. Representative Missouri weeds and their control. Mo. Agr. Exp. Sta. Bul. 433.
5. Fendall, R. K., and Jack F. Carter. 1965. New-seed dormancy of green needlegrass (*Stipa viridula* Trin.). I. Influence of the lemma and palea on germination, water absorption and oxygen uptake. *Crop Sci.* 5:533-536.
6. Fernald, M. L. 1950. *Gray's Manual of Botany*. 8th Edition. (Amer. Book Co., N. Y.).
7. Mayer, A. M., and A. Poljakoff-Mayber. 1963. *The Germination of Seeds*. (MacMillan Co., N.Y.).
8. Meyer, B. S., and D. B. Anderson. 1952. *Plant Physiology*. (D. Van Nostrand Co., Princeton, N.J.).
9. Steyermark, Julian A. 1968. *Flora of Missouri*. (Ia. State Univ. Press, Ames).