Seed Viability and Growth Characteristics of *Eclipta prostrata* (L.) L.

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한련초의 種子生存力 및 生長特性

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ABSTRACT

Several experiments were conducted to investigate the achene viability and growth characteristics of *Eclipta prostrata* (L.) L. No dormancy and no after-ripening requirement were found for *E. prostrata* achenes. When achenes were stored at room temperature, germination did not decrease with up to 5 months storage. Large differences in loss of viability of *E. prostrata* achenes occurred when different dehydration methods were used. Immediate dehydration resulted in high viability, but slow dehydration resulted in severe loss of viability.

Achene viability at shallow burial depths (5 and 10 cm deep) was lower under upland soil conditions than under lowland soil conditions. Seedling growth was greatly reduced when flooding to a depth of 10 cm occurred at or before the 4-leaf stage. Flooding after the 4-leaf stage stimulated stem elongation. Branching started from the second week and usually terminated at the tenth week. Leaf size was determined by the branch which are related to the assimilate supply. Flowering of *E. prostrata* started during the fifth week after emergence, and mature achenes were produced from the sixth week. Ten to 14 days were needed for the achenes to mature. About 14,000 achenes were produced on each plant. Achene production per week increased from the sixth week to the tenth week and thereafter it declined. The average number of achenes per inflorescence decreased with delay in flowering.

Key words : *Eclipta prostrata*, achene viability, growth chracteristics.

INTRODUCTION

Eclipta prostrata (L.)L. is widely disrtributed in the tropical, subtropical and warmer temperature regions. This indicates its high adaptability to changing environmental conditions, Merrill (10) stated that once *E. prostrata* is introduced into a new country, it aggressively establishes and persists with Napoleonic ambitions as long as growth conditions are favorable.

Dormancy often enables seed to germinate when conditions are favorable for survival of the germinated seedlings, or insures that all seeds of a given population do not germinate at the same time (5). In general, seed dormancy increases changes for seedling establishment.

However, some weed seeds show no dormancy (16). In the tropical regions, many seeds have no domancy and generally germinate soon after

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reaching the ground (7). For example, the achenes of *E. prostrata* were reported to have no dormancy (13, 16).

The effect of dehydration and rehydration upon seeds are complex and difficult to perdict. King (7) stated that even in an undisturbed soil, germination of *Digitaria sanguinalis* (L.) Scop. was increased by alternate wetting and drying. Germination of *Setaria faberii* Herrm. could be stimulated by allowing the soil to dry out followed by a period of ideal cultural conditions; alternate wetting and drying may assist in the removal of inhibitory substances from the seeds (7).

Similar results were reported by Hegarty (6), Vincent and Carvers (18), and Egley and Duke (4). For *Rumex crispus* L., dehydration and rehydration increased the speed of germination (18). Egley and Duke (4) also stated that rehydration of seeds previously imbibed and then dried often resulted in more rapid and higher germination percentage than that of seeds that had not been allowed to dry.

These results may partially explain why weed seedlings appear rapidly from seeds near the soil surface after a drought-ending rain. Generally, alternate wetting and drying encourages weed seed germination provided that embryo does not occur (2).

Photosynthetically, *E. prostrata* is a C_3 plant (9, 11, 17). In some plants like *E. prostrata*, the flowers are axillary and borne on lateral shoots; vegetative growth and flowering occur concurrently. However, there is nearly always a certain minimum period of purely vegetative growth.

This experiment was conducted to investigate the achene ability under different conditions and the growth chracteristics of *E. prostrata*.

MATERIALS AND METHODS

Dormancy and viability. A completely randomized design with four replications was used. Achenes harvested at the same time were stored in the laboratory at room temperature for 0, 0.5, 1, 3, 5, 7, 9 and 12 months following which germination tests were conducted at 35/20℃ for 12 hr each with constant light. Fifty achenes were placed in a 9 cm diameter plastic petri dish containing Whatman No. 1 filter paper moistened with 7 ml of distilled water for each replication. The petri dishes were randomly arranged in an incubator and their positions were changed both horizontally and vertically daily. The non-germinated achenes from the previous test were treated with 0.2% TTC(trichloro tetrazolium chloride) for 5 days. The achenes were considered to be viable the embryos were stained pink to red.

Alternate wetting and drying. A completely randomized design with four replications was used. Achenes were subjected to seven alternate wetting and drying cycles by drying on the soil surface or in 5×6 cm nylon mesh packets. The achenes were moistened for 1 day in the dark and then they were dried for 2 days under natural light. This cycle was repeated as many times as necessary. After the alternate wetting and drying treatment, the achenes were placed in an incubator with alternating temperatures of 35/20℃ for 12 hr each and constant light.

Effect of burial. A completely randomized design with four replications was used. Achenes were buried in 5×6 cm nylon mesh packets to different depths in upland and lowland soils. After burial for different periods, the exhumed achenes were placed in an incubator with alternating temperatures of 35/20℃ for 12 hr each and constant light. The factors and their levels were as follows:

soil condition : upland and lowland soil

burial depth : 5, 10, 15, 20, 25 and 30 cm from the soil surface

burial duration : 1, 3, 6 and 12 months

Flooding. A completely randomized design with four replications was used. The seedlings were flooded 10 cm deep, 8, 15, 20 and 24 days after emergence (DAE), corresponding to the 2, 4, 6 and 8-leaf stages, respectively. An unflooded control was included for comparison purposes. Seedlings were sampled for data collection at 40 DAE.

Growth and development. Achenes collected from the experimental fields of IRRI were seeded in 16.5 cm diameter plastic pots filled with silt loam soil. Twelve g N/m² was applied on the soil surface 2 days before seedling. At the 2-leaf stage, the seedlings were thinned to one per pot. The pots were sub-irrigated to minimize soil compaction. The achenes were collected daily from 12 plants and bulked to determine the total number of achenes per plant.

RESULTS AND DISCUSSION

Dormancy and Viability

No dormancy and no after-ripening requirement were found for *E. prostrata* achenes (table 1). The achenes germinated immediately after maturity. When the achenes were stored at room temperature, germination did not decrease with up to 5 months storage, but the germination speed decreased with increase in the storage period.

Table 1. Germination of *Eclipta prostrata* achenes as affected by length of storage.[a]

Storage duration (Month)	Days to 50% germination	Germination (%)
0	3	93.0 a
0.5	3	94.5 a
1	4	93.5 a
3	4	95.0 a
5	5	91.0 a
7	7	(41.0)[b] b
9	-	0.0 c
12	-	0.0 c

[a] In a column, means followed by the same letter are not significantly different at the 5% level by DMRT.

[b] Radicle development ceased after protrusion from the fruit wall.

After 7 months of storage, only 4% of the achenes germinated, but radicle development of all the seedlings ceased after protrusion out of the fruit wall. These seedlings eventually died because of limited nutrient absorption. Achenes stored for 9 months or more were no longer viable.

The nondormancy of *E. prostrata* is important ecologically. This enables plants to produce more than one generation each year provided there are

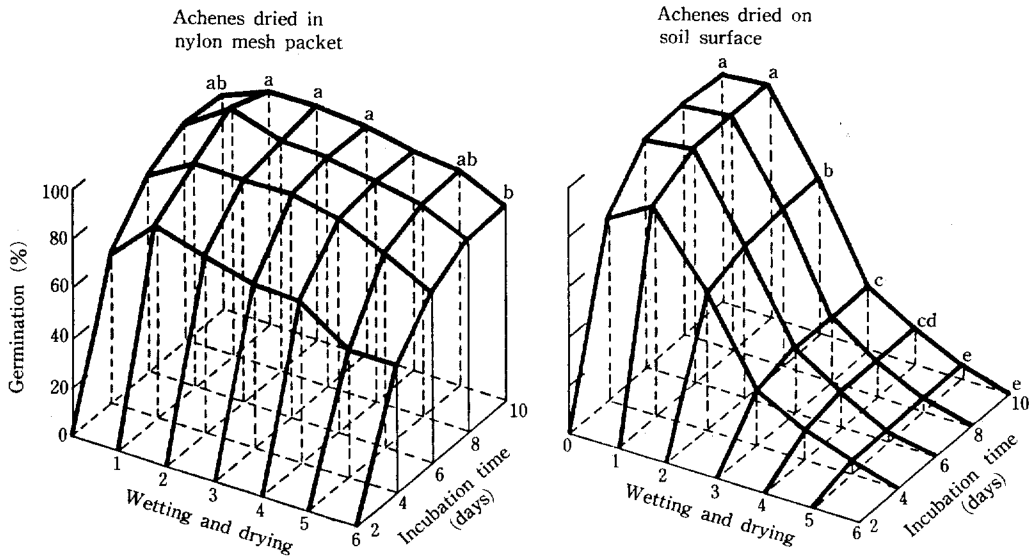

Fig. 1. Percent germination of *Eclipta prostrata* achenes as affected by the number of wetting and drying cycles and different dehydration methods. (Means followed by the same letter are not significantly different at the 5% level by DMRT).

prolonged conditions for germination and establishment. *E. prostrata* produces with 6 weeks after emergence (see Fig. 5).

Alternate Wetting and Drying

Large differences in loss of viability of *E. prostrata* achenes occurred when different dehydration methods were used (Fig. 1). Immediate dehydration resulted in high viability, but slow dehydration resulted in severe loss of viability.

When the achenes were subjected to wetting and drying cycles in nylon mesh packets, viability was maintained until the fifth cycle. In contrast, achenes which were dried on the soil surface rapidly lost their viability with increase in the number of wetting and drying cycles.

The achenes which were placed in the nylon mesh packets dried immediately. In contrast, when achenes were placed on the soil surface, the achenes did not dry until the soil dried which took 30 to 60 minutes. Thus, the achenes probably started to germinate. These achenes were damaged during subsequent dehydration because the metabolic processes of germination are initiated during soaking, and these events are merely arrested, not reversed, by subsequent drying (3). This result implies that severe loss of achene viability can occur in the field.

Effect of Burial

Achene viability was maintained for 12 months following burial under both upland lowland soil conditions. Differences in viability were observed as a result of differences in the duration and depth of burial under different soil conditions (Fig. 2).

In the upland soil, achene viability at the 15 cm depth was 33.5% after 12 months burial. In the lowland soil, high viability was maintained at burial depths ranging from 5 to 25 cm for 6 months. By 12 months, viability was significantly reduced as the burial depth increased.

The low viability at shallow burial depths (5 to 10 cm deep) under upland conditions was probably due to fluctuations inn soil moisture (14). In contrast, the high viability in lowland conditions at the same depths was probably due to less fluctuation in these factors as a result of flooding. The reasons for the loss of viability at the greater burial depths under both soil conditions are not

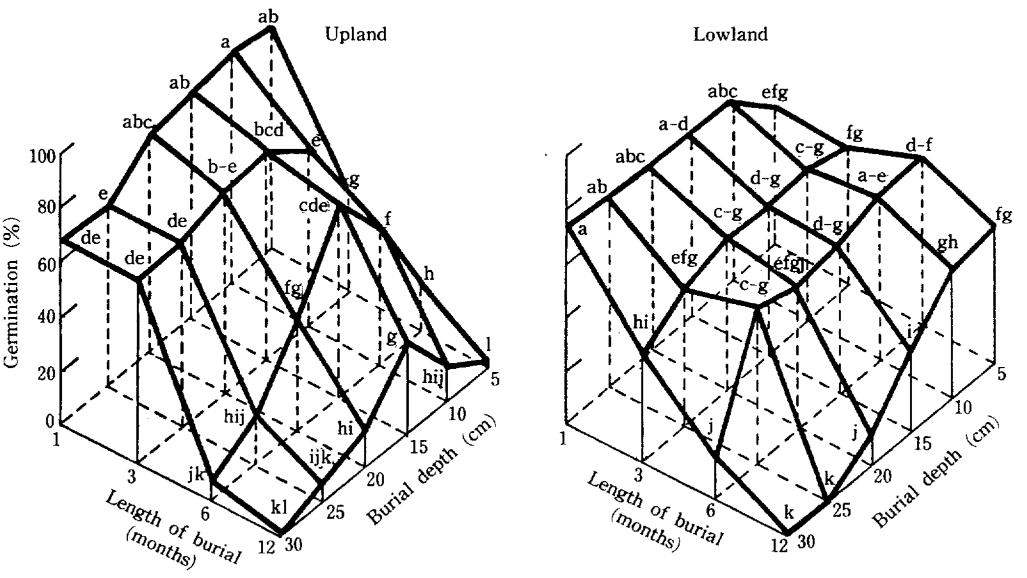

Fig. 2. Percent germination of *Eclipta prostrata* achenes as affected by different depths and lengths of burial under upland and lowland conditions. (Means followed by the same letter are not significantly different at the 5% level by DMRT.)

Table 2. Effect of flooding 10 cm deep on the growth of *Eclipta prostrata*.[a]

Seedling condition before flooding			Seedling growth at 40 DAE	
Leaf stage	DAE	Plant height (cm)	Plant height (cm)	Shoot weight (mg/plant)
2	8	1.5	3.3 d	3 c
4	15	3.2	7.4 c	8 c
6	20	4.3	23.8 a	454 b
8	24	4.8	23.9 a	532 a
Unflooded	-	-	15.8 b	565 a

[a] In a column, means followed by a common letter are not significantly different at the 5% level by DMRT. DAE=days after emergence.

known.

Flooding

Seedling growth was greatly reduced when flooding occurred at or before the 4-leaf stage. Flooding after the 4-leaf stage stimulated stem elongation (Table 2). Flooding at the 4-leaf stage resulted in a 53% reduction in plant height compared to unflooded control. In contrast, when the seedlings were flooded at the 6-leaf stage, they were 51% taller than those in the unflooded control at 40 DAE. When flooding occurred at the 4-leaf stage or earlier, each pair of leaves folded upward. This was probably caused by turgor change in the petiole cells due to inhibited respiration.

Thus, the response of seedlings of *E. prostrata* to flooding varied remarkably at different growth stages. Seedlings at the 6-leaf stage (which appears to be a critical stage) or older will persist and become acclimatized under flooded conditions. Singh et al.(15) reported that *E. prostrata* at the vegetative stage was defoliated except for the terminal as a result of flooding 90 cm deep for 4 days, but at the flowering stage there was no effect.

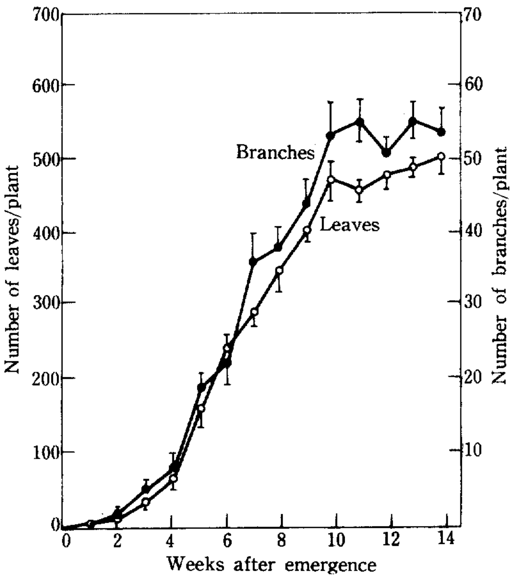

Fig. 3. Changes in the number of branches and leaves per plant of *Eclipta prostrata* across time under greenhouse conditions. (Vertical bars indicate standard deviation of mean.)

Number of branches and leaves. Branching started from the second week and usually terminated at the tenth week. The total number of branches was 22 and 53 at the sixth and tenth week, respectively (Fig. 3). The number of leaves incresed with increae in the number of branches.

When the eighth leaf had expanded, the frist primary branch was produced from the first axil of the main stem (Fig. 4). Formation of primary branches proceeded from the lower nodes to the upper nodes of the main stem. In general, the first and second primary branches produced several secondary branches.

The leaves on the main stem were generally large than those on branches, and the leaves on the secondary branches were generally smaller than those on the main stem and the primary branches (Fig. 4). Leaf size seemed to be determined by branching time and the position of

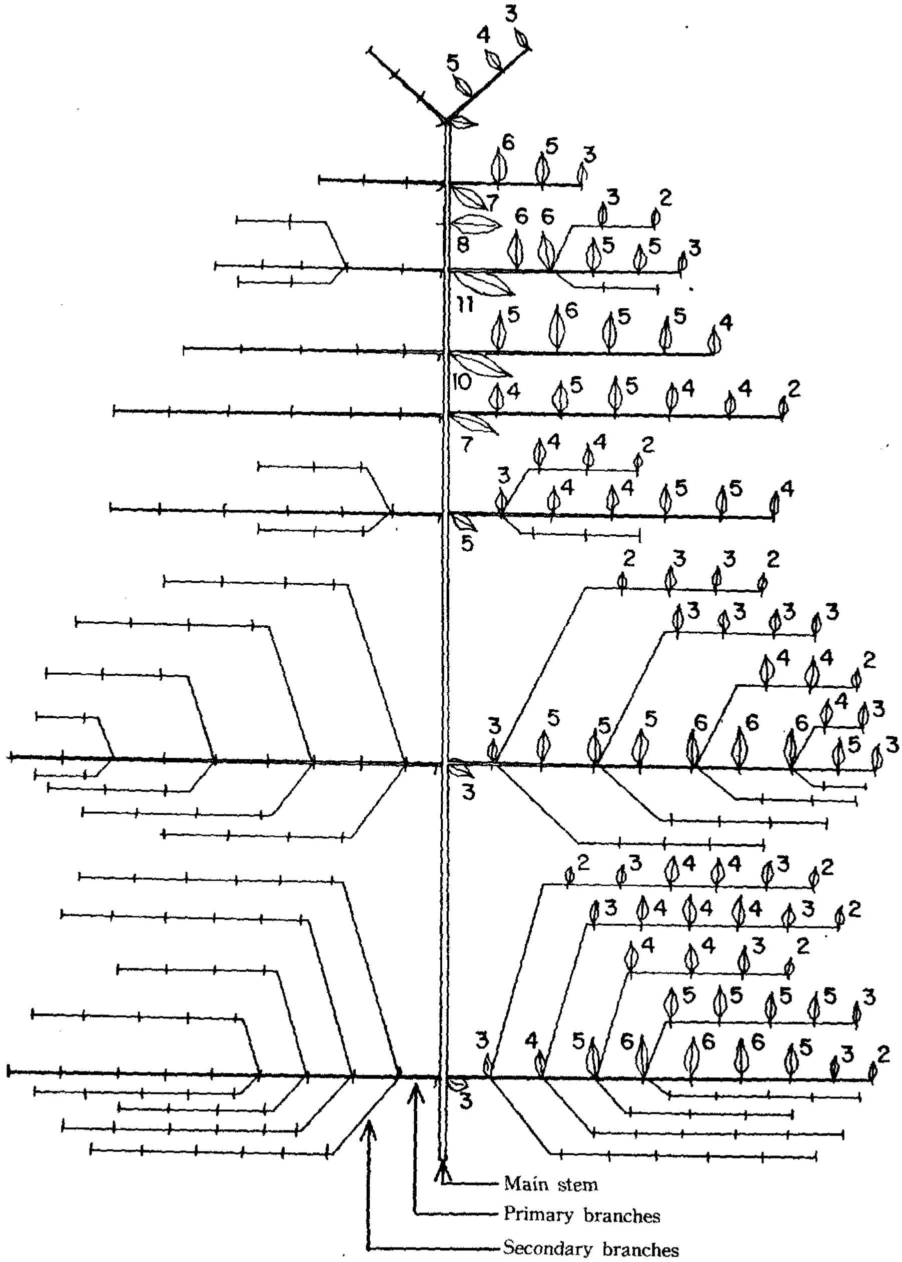

Fig. 4. A diagram of an *Eclipta prostrata* plant showing the leaf sizes on the main stem and the primary and secondary branches at 75 days after emergence under greenhouse conditions. (Numbers following leaves indicate leaf length in centimeters.)

the leaf on the branch which are related to assimilate supply. In the case of the leaves on the main stem, the enlargement of leaves was inhibited by earlier branching. Therefore, the leaves at the upper nodes were larger than those at the lower nodes. The leaves on the primary branches were also dependent on the formation time of the secondary branches seemed to depend on the formation time and the relative distance from the primary branches.

Reproductive growth. Flowering of *E. prostrata* started during the fifth week after emergence, and mature achenes were produced from the sixth week (Fig. 5). Usually 10 to 14 days were needed for the achenes to mature. About 200 inflorescences and about 14,000 achenes were produced on each plant. Achene production per week increased from the sixth week to the tenth week and thereafter it declined. Continuous seed production is one of the ideal characteristics of weed (1).

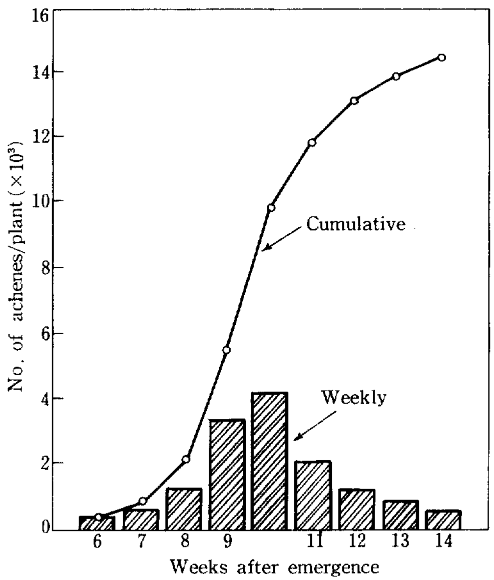

Fig. 5. Change in the number of achenes per *Eclipta prostrata* plant across time under greenhouse conditions.

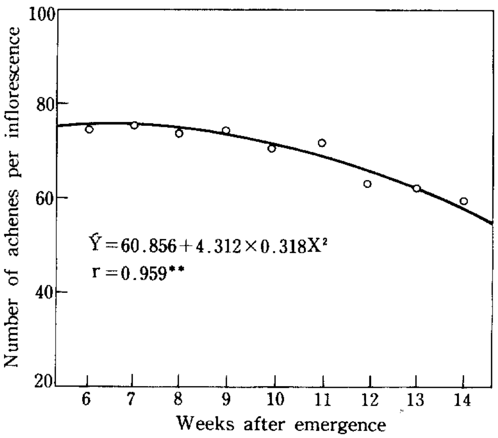

Fig. 6. Change in the number of achenes per *Eclipta prostrata* inflorescences plant across time under greenhouse conditions.

The number of achenes produced per *E. prostrata* plant is very variable in different locations. It was 909, 17, 323, and 1, 514 in India, the Philippines, and Japan. respectively (8, 12, 13).

The average number of achenes per inflorescence decreased with delay in flowering -- 74.9 were produced during the sixth week, 71.4 during the tenth week, and 60.0 during the fourteenth week (Fig. 6).

摘　　要

한련초의 種子 生存力, 深水管理에 依한 初期生長 反應 및 生長特性을 究明하기 爲하여 數個의 試驗이 遂行되었다. 한련초 種子는 休眠性이 없었으며 室溫에 貯藏된 種子는 5個月까지 높은 發芽率을 보였다. 水分吸收와 乾燥의 反復에 따른 種子 生存力의 喪失은 乾燥方法에 따라 크게 달랐다. 吸水狀態에서 乾燥狀態로 빠른 轉換은 比較的 높은 生存力을 維持했으나 서서히 乾燥된 種子는 發芽中인 胚의 損傷으로 極甚한 生存力 喪失을 가져왔다. 土壤 5～10cm 깊이에 있는 種子는 밭보다 논條件에서 더 오래 生存力을 維持하였다. 4葉期 以前의 深水管理(10cm)는 伸長을 크게 抑制하였으나 그 以後부터의 深水管理는 오히려 伸長을 刺戟하여 無處理보다 草長이 有意 增加되었다. 分枝는 出現後 2週째부터 始作하였고 普通 10週째까지 繼續되었다. 잎 크기는 同化産物의 供給과 關聯되어 分枝時期와 잎의 發生位置에 따라 決定되었다. 出現後 5週째부터 開花가 始作되었고 1個 花序가 登熟하는 데에는 10～14日이 所要되었다. 個體當 種子는 約 14,000個였다. 1日 種子生産量은 出現後 10週째까지 增加하다가 그 後 減少하였으며 1花序當 種子數는 늦게 發生된 花序일수록 減少하였다.

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