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Development of Small White Flower Morningglory Seeds and Influence of Storage on Their Germination and Viability

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ABSTRACT

Development of small white flower morningglory seeds were studied in the field and laboratory. Seeds reached their physical maturity and field maturity stage at day 21 and day 27 to 28 after blooming, respectively. Seeds collected at day 21 after blooming had 96% germination. Hardseeds developed at day 24 to 25 after blooming and germination decreased to 20% or less when harvested 25 days or more after blooming. The germination of seeds collected in the field at field maturity in the dry season was less than the seeds collected in the rainy season. Storage of hardseeds under room temperature for 66 weeks did not affect germination, but acid scarification increased germination. Storage of acid-scarified hardseeds under room temperature decreased their germination and coefficient of velocity but increased the percentage of non-viable seeds. At week 35 after storage, 48% of acid-scarified hardseeds seeds could germinate. The germination percentage of unscarified hardseeds stored in soil was reduced when increasing the period of storage. At week 77 after placing hardseeds in soil, 22% of seeds could germinate after acid scarification.

Key words: small white flower morningglory, *Ipomoea obscura* (L.) Ker-Gawl, seed development, seed storage, hardseed, seed dormancy

INTRODUCTION

Small white flower morningglory [*Ipomoea obscura* (L.) Ker-Gawl] is a vine found in humid tropical (Elmore *et al*., 1990). It was reported that this weed infested pineapple plantations in Rayong province, approximately 180 km east of Bangkok (Laosinwattana, 1994). This weed species became a problem because of the application of herbicides. Bromacil alone or in combination with diuron at planting and at 3 to 4 months after planting could control this weed. However, it appears again at 6 months when no selective herbicide applied in pineapple plantation.

The weeds in genus *Ipomoea* propagate by either sexual or asexual reproduction. However, asexual reproduction of these weeds are very limited (Elmore *et al*., 1990). The distribution of most weeds in this genus occurred by seed (Stucky and Beckmann, 1982). Seed production of weeds in the genus *Ipomoea* was studied in tall, ivyleaf, small flower, pitted, cypressvine, cotton and palmleaf morningglories (Crowley and Buchanan, 1982; Gomes *et al*., 1978; Thullen and Keeley, 1983). Furthermore, Johnson *et al*. (1977) reported the seeds of plants in genus *Ipomoea* had dormancy because they developed hardseededness. Therefore, they germinate gradually in the field. Most of the

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dormant seeds accumulate in the soil seed bank because only germinated seeds will be controlled by pre-emergence herbicide. Information on seed development and germination of small white flower morningglory seeds has not been reported in Thailand.

The objectives of this experiment were to determine the development and germination of small white flower morningglory seeds and the effect of seed storage on their germination.

MATERIALS AND METHODS

Seed development

Seed pods of small white flower morningglory were collected from a commercial pineapple field at Rayong province in the first week of April 1996. A few days after collection the capsules were sun-dried and the seeds were separated from the dried capsules. Seeds were planted at 2-3 cm deep in pots containing clay loam soil (23% sand, 35% silt, 42% clay, and 0.7% organic matter) obtained from the pineapple field. Pots were placed outdoors (30-38°C), and watered as necessary. At day 20 after planting, the seedlings of small white flower morningglory were thinned to one plant/pot and grown outdoors until the first bloom. Each flower was tagged and labeled with the date upon first bloom. The period between blooming and development of the seed capsules was recorded and the capsules were collected. The seeds were separated from the capsule and the fresh weight was recorded. Some seeds were dried in an oven at 80°C for 2 days and the dry weight was recorded to determine seed moisture content. Another group of seeds was germinated in a 10 cm diameter petri dishes on two layers of 9 cm diameter germinating paper with 8 ml of distilled water. All petri dishes were placed in an unlit germingating chamber at 27°C. Seed germination was recorded daily for 14 days. If the length of radicle was longer than 0.3 mm, seed was considered germinated. The viability of ungerminated seeds was determined by tetrazolium test. The germination data were used to calculate germination percentage. The coefficient of velocity was calculated by the following formula (Stoller and Wax, 1974):

Coefficient of velocity (CV) = 100[SNi / SNiTi]

When, Ni = The accumulated number of germinated seed until day i

Ti = The number of days [i] after sowing

Seasonal influence on seed germination

Seed development of small white flower morningglory was initially studied as described above. The seeds of small white flower morningglory were considered reaching field maturity when the capsule split and the seed color changed to dark brown. In this experiment the capsules containing the seeds which reached field maturity were collected in the rainy and dry seasons in 1997 and 1998 as tabulated in Table 3. The seeds were separated from the capsules and germinated and the data were collected as described in the seed development experiment.

Seed storage under room temperature

The seeds which reached field maturity were collected from plants grown in the seed development study. Seeds were separated from the capsules and stored in cotton bags at room temperature (28-33°C). There were three experiments involving storage duration of seeds receiving different scarification treatments at room temperature.The scarification treatments included 1) store non - scarified seeds, 2) acid-scarified seeds after storage but prior to germination, and 3) acid-scarified seeds before storage. For the scarified seeds, seeds were scarified with 97.7% H_2SO_4 for 80 minutes and rinsed with tap water for 5 minutes. Non-scarified seeds and scarified seeds after storage were stored up to 66 weeks prior to germination, while seeds that were scarified prior to storage were stored up to 35 weeks. The seed

germination was conducted in the same manner as described in the seed development experiment.

Seeds storage under different soil depths

One hundred seeds collected at field maturity stage were placed in plastic mesh screens of 5 cm wide, 10 cm long, and 5 cm deep. These screens were placed in clay loam soil at 20 cm deeps under field conditions at approximately 26-32°C. This method was modified from that reported by Burnside *et al*. (1996). During one to seventy-seven weeks in soil storage the seeds were acid-scarified, then germinated in the same manners as described in the seed development experiment. Data were collected, calculated and tabulated in Table 7.

In all experiments, 25 seeds of small white flower morningglory were placed in each perti dish. One petri dish was designed as one treatment and each treatment was replicated 4 times. All experiments were designed as a completely randomized design and each experiment was repeated twice. The experiments were conducted at the Seed Laboratory, Dept. of Agronomy, Faculty of Agriculture, Kasetsart University, Chatuchak, Bangkok and at Central Laboratory, Faculty of Agriculture Rachamongkala Institute of Technology, Bangpra Campus, Sriracha, Cholburi, Thailand.

RESULTS AND DISCUSSION

Seed development

The development of small white flower morningglory seeds was studied during November 1996- December 1997. It was found that the flowers started to bloom around 7:30-8:00 AM and terminated at 1:00 PM of the same day. They bloomed only this period. After that the corolla shrank and dropped within 24 hours after blooming. While the capsule (fruit) started to develop, the pedicel bent downward. The bending of pedicel occurred immediately after termination of blooming period. The color of young capsule was light green for the first two days and became darker green during 10 to 13 days after blooming and the capsule also enlarged. At day 14 to 15 after blooming the color of the capsule became purple before it started to reach maturity. At day 18, the capsule color changed to rice-straw color and when it was mature it became dark brown. The outer surface of the capsule also started to split at day 21 to 22 after blooming and there were 2 to 4 seeds in one capsule. The color of mature seed coat was dark gray when the seed was mature at day 21. Other developmental aspects of the seed development were as follows :

Dry weight accumulation

After the capsule started to develop, the 100 - seed dry weight gradually increased from about 0.3 g at day 10 after blooming to about 2 g at day 21 after blooming (Table 1). After 21 days, the weight of the seeds was stable. At day 28 after blooming, the seed dry weight slightly decreased.

Moisture content

Seed collected at day 10 after blooming had a moisture content of 90.2 percentage (Table 1). However, the moisture content gradually decreased until 21 days after blooming. The sharpest decrease in seed moisture content occurred during 17 to 18 days after blooming. At day 21 the capsule started to dry out and the outer surface split. The moisture content continued to drop to approximately 14% at day 28 after blooming. From this period until 32 days after blooming the moisture content was relatively stable.

Germination

The seeds of small white flower morningglory collected prior to day 18 after blooming could not germinate (Table 2). At day 18 the color of seed coat changed from light green to light brown while the color of capsule changed from purple to rice-straw color. The germination

percentage of the seeds increased sharply during 18 to 20 days after blooming, and reached a peak of 96% at day 21. The germination percentage of seed collected 24 days or more after blooming decreased sharply until 30 days after blooming when germination decreased to only 6%. The highest coefficient of velocity (34.8) was observed at day 21 after blooming and declined after that while the color of the seed coat became dark gray. At day 26 after blooming the coefficient of velocity was only about 8 until 30 days after blooming (Table 2). At this period the capsule had already split resulting in dropping of the seeds at day 45 after blooming. The results indicated that the seeds of small white flower morningglory reached the physical maturity 21 days after blooming. This was similar to the development of purple moonflower morningglory (*Ipomoea turbinata* Lag.) seeds (Chandler *et al*., 1977).

It was observed that the hardseeds of small white flower morningglory developed during 24 to 25 days after blooming when the percentage of viable seeds increased but the germination percentage decreased (Table 2). A number of ungerminated seeds found could possibly be the result of the impermeability of the seed coat which was observed in many *Ipomoea* species (Elmore *et al*., 1990). However, this type of dormancy might be referred to as coat- imposed dormancy while the other type of dormancy is influenced by the embryo (Bradbeer, 1988; Kelly *et al*., 1992).

When the hardseededness developed during 24 to 25 days after blooming the moisture content in the seeds was still high (Table 1). The appropriate period for collecting seeds should be during 27 to 28 days after blooming which is the field maturity period as noted by the increase in viable seeds to about 80 to 90% and decrease in moisture content to approximately 14% (Table 1).

Seasonal influence on seed germination

Collecting the seeds of small white flower morningglory at different seasons affected seed germination. It was observed that from the first experiment when the capsule had already split and became dark brown, the seeds were at field maturity. Field-matured seeds collected in the dry season (December to April) had a lower germination percentage than those in the rainy season (August) (Table 3.) The moisture content in soil and relative humidity during seed development might affect their germination and relative humidity during seed development might affect their germination

Table 1 Dry weight and moisture content of small white flower morningglory seeds after blooming.

Days after blooming	Dry weight (g/ 100 seeds)	Moisture content of seeds (%)
10	0.33 j [1/]	90.2 a
11	0.44 ij	89.4 a
12	0.55 i	87.3 ab
13	0.70 h	85.4 ab
14	0.91 g	81.5 bc
15	1.00 g	80.4 bc
16	1.30 f	75.4 c
17	1.61e	66.2 d
18	1.76 d	52.3 e
19	1.79 d	49.3 ef
20	1.84 cd	40.6 g
21	2.01 ab	41.9 fg
22	2.08 a	35.5 g
23	2.04 ab	26.7 h
24	1.98 ab	18.0 ij
25	2.04 ab	20.3 ij
26	2.02 ab	17.0 ij
27	1.99 ab	12.5 j
28	1.94 bc	14.4 ij
29	1.97 ab	14.3 ij
30	1.99 ab	14.5 ij
31	1.93 bc	12.8 ij
32	1.98 ab	10.3 j
CV (%)	5.50	12.16

[1/] Means within the same column followed by the same letter are not significantly different at 95% by Duncan's New Multiple Range Test (DMRT).

and dormancy (Morley, 1958).

Seed storage under room temperature

Non-scarified seed The germination percentage of non-scarified seed decreased from 16% at week 0 of storage to 7% at week 54 (Table4). At week 66 after storage the germination percentage was only 5% while the percentage of non-viable seeds increased. However, storage period did not affect the coefficient of velocity. The percentage of viable ungerminated seeds was still high (56%) after 66 weeks in storage. Thickening of the seed coat (hardseed development) may help maintain seed viability. It

Table 2 Germination and coefficient of velocity of small white flower morningglory seeds at 14 to 30 days after bloooming.

Days after blooming (days)	Germination (%)	Ungerminated seeds		Coefficient of velocity
		Viable (%)	Non-viable (%)	
14	0 [1/]	0	100 a	0.0
15	0	0	100 a	0.0
16	0	0	100 a	0.0
17	0	0	100 a	0.0
18	8 gh	0	92 b	20.0 cd
19	27 e	0	73 c	26.7 b
20	91 b	0	9 d	27.3 b
21	96 a	0	4 e	34.8 a
22	93 ab	2 f	5 de	21.8 c
23	85 c	9 e	6 de	18.2 d
24	56 d	38 d	6 de	17.8 d
25	20 f	73 c	7 de	17.5 d
26	11 g	84 b	5 de	8.3 e
27	9 gh	87 ab	4 e	8.4 e
28	6 h	90 a	4 e	8.3 e
29	5 h	91 a	4 e	8.6 e
30	6 h	89 a	5 de	8.5 e
CV(%)	7.26	4.44	12.33	12.30

[1/] Means within the same column followed by the same letter are not significantly different at 95% by DMRT.

Table 3 Influence of growing season on germination of small white flower hardseeds.

Season	Date of collection	Germination (%)	Ungerminated seeds		CV (%)
			Viable (%)	Non-viable (%)	
Rainy	August 30, 1997	16.b [1/]	81 a	3 c	6.00
Dry	December 4, 1997	6 b	91 a	3 b	6.69
Rainy	August 29, 1998	24 b	62 a	14 c	11.31
Dry	April 10, 1998	12 b	84 a	4 c	7.21

[1/] Means within the same row followed by the same letter are not significantly different at 95% by DMRT.

could be concluded that storage of non-scarified seed under room temperature for 66 weeks decreased seed germination but did not affect the coefficient of velocity. While the percentage of viable ungerminated seeds gradually declined, the percentage of non-viable seeds increased.

Post-storage acid scarification The effect of seed storage at room temperature for 66 weeks are presented in Table 5. The germination percentage and coefficient of velocity of seeds were still high until 37 weeks in the storage. After that the germination percentage and coefficient of

Table 4 Germination and coefficient of velocity of non-scarified small white flower morningglory hardseeds after storage at room temperature for 66 weeks.

Duration (weeks)	Germination (%)	Ungerminated seeds		Coefficient of velocity
		Viable (%)	Non-viable (%)	
0	16 a [1/]	81 a	3 e	32.6 a
1	16 a	78 ab	6 e	30.4 a
10	14 ab	78 ab	8 de	25.0 a
19	13 abc	70 bc	17 cd	24.8 a
28	12 abcd	68 bc	20 c	27.9 a
37	12 abcd	66 cd	22 bc	32.5 a
42	13 abc	65 cd	22 bc	26.3 a
48	13 abc	66 cd	21 c	25.9 a
54	7 bcd	62 cd	31 ab	16.3 a
60	6 cd	60 cd	34 a	18.8 a
66	5 d	56 d	39 a	24.3 a
CV(%)	44.22	10.39	32.54	50.72

[1/] Means within the same column followed by the same letter are not significantly different at 95% by DMRT.

Table 5 Germination and coefficient of velocity of post-storage scarified hardseeds of small white flower morningglory after storage at room temperature for 66 weeks.

Duration (weeks)	Germination (%)	Non-viable seeds (%)	Coefficient of velocity
0	95 a[1/]	5 e	50.2 abc
1	94 a	6 e	48.8 bc
10	91 a	9 e	59.9 a
19	88 ab	12 de	54.0 ab
28	89 ab	11 de	54.4 ab
37	89 ab	11 de	41.0 c
42	78 b	22 d	43.8 c
48	64 cd	36 bc	30.8 d
54	65 c	35 c	27.3 d
60	52 d	48 b	30.0 d
66	39 e	61 a	25.6 d
CV(%)	11.28	37.19	16.02

[1/] Means within the same column followed by the same letter are not significantly different at 95% by DMRT.

velocity decreased to 39% and 25.6, respectively, at week 66 in the storage. However, the percent of non-viable seeds increased to 61%. These results indicated that seeds still needed acid scarification to germinate even though they were stored for 66 weeks (Table 4 and 5).

Pre-storage acid scarification The germination percentage and coefficient of velocity of seeds decreased from 94% to 48% and 38.5 to 21.7, repectively, but the non-viable seed increased from 6% to 52% as the duration of storage increased (Table 6). The moisture inside the scarified seeds can change depending on the moisture of the atmosphere outside the seed (Leopold and Kriedemann, 1975). Acid scarification may have reduced seed coat thickness, thereby increasing respiration rate, moisture and gas exchange between the atmosphere outside and inside the seeds. Therefore, these factors might affect the germination of the seeds. At 35 weeks of storage, seed germination was 48% (Table 6) while the germination percentage of the post-storage scarified seeds was 89% (Table 5). Even at 60 weeks of storage, the germination percentage of the post-storage scarified seeds was 52%. The germination percentage of scarified seeds (Table 5 and 6) was greater than non –scarified seeds (Table 4) regardless of the storage period or time of scarification.

Storage of seeds in soil

When the seeds were stored in clay loam soil at 20 cm deep, the germination percentage of the seeds decreased as the duration of storage increased (Table 7). Furthermore, seed loss was increased as the duration of storage increased. These lost seeds (germinated and ungerminated) might have been decayed by soil microorganisms (Egley , 1995) or destroyed by predators (Fenner, 1995). The previous report indicated that seeds of small white flower morningglory did not emerge when they were placed at 12 cm deep (Julakasewee, 2001). However, 22% of the seeds could germinate after 77 weeks placing in the soil (Table 7). The hardseeds of pitted morningglory and purple moonflower morningglory were viable in soil longer than 5.5 years (Egley and Chandler, 1983). Ivyleaf morningglory hardseeds were viable in soil more than 3 years (Stoller and Wax, 1974).

In this experiment the seeds were placed at 20 cm deep where they could not emerge but were still viable at week 77. There were several reports indicating that shallow cultivation practice might stimulate weed seed germination because seeds were brought to the soil surface where the environmental conditions were appropriate for

Table 6 Germination and coefficient of velocity of pre-storage hardseeds of small white flower morningglory after storage under room temperature for 35 weeks.

Duration (weeks)	Germination (%)	Non-viable seeds (%)	Coefficient of velocity
0	94 a [1]	6 e	38.5 b
5	76 b	24 d	43.9 ab
11	72 bc	28 cd	44.7 ab
17	65 bcd	35 bcd	56.4 a
23	59 cde	41 abc	45.6 ab
29	55 de	45 ab	22.0 c
35	48 e	52 a	21.7 c
CV(%)	13.24	26.88	24.80

1/ Means within the same column followed by the same letter are not significantly different at 95% by DMRT.

Table 7 Germination of post-storage scarified hardseeds of small white flower morningglory after storage in soil at 20 centimeter deep for 77 weeks.

Duration (weeks)	Lost seeds (%)	Remaining seeds (%)	Germination (%)	Non-viable seeds (%)
1	6 f [1]	94 a	90 a	4 b
7	34 e	66 b	48 b	18 a
13	40 de	60 bc	40 c	20 a
19	43 cd	57 cd	39 cd	18 a
25	45 bcd	55 cde	35 cde	20 a
31	50 bc	50 bc	31 de	19 a
54	52 b	48 e	28 ef	20 a
77	63 a	37 f	22 f	15 a
CV(%)	14.05	10.11	12.85	32.25

[1/] Means within the same column followed by the same letter are not significantly different at 95% by DMRT.

germination. Deep cultivation practice might stimulate the seeds to become dormant because at the deep soil level, the environmental factors were unappropriate for germination (Warnes and Anderson, 1984; Egley and William 1990; Lueschen *et al.,* 1993). However, cultivation or application of herbicides might not affect the ungerminated seeds and these seeds could remain in the soil and became the problem in the following crops (Bridgemoham *et al*., 1991).

CONCLUSION

The results of this experiment indicated that if a small white flower morningglory plant is destroyed prior to 21 days after blooming, then that plant will not produce viable seed to contribute to the soil seed bank. While the weed may be less prevalent during the dry season (Julakasewee, 2001) a greater percentage of the seeds produced are hardseeds which may remain in the soil seed bank for longer period of time. In addition, the ability of non- scarified seed to remain viable during storage might explain why small white flower morningglory can emerge and establish in herbicide treated pineapple fields six months after planting. Although the residual herbicide bromacil is often applied at planting time and at 3 or 4 months after planting. This study suggested that the seed can remain viable for one year and six months or more. Therefore, the viable hardseeds can emerge after the residual activity of the herbicide has ended.

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