SEED GERMINATION IN

POLYGONUM LONGISTYLUM L.

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by

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INTRODUCTION

It is well established that seeds of Polygonum are difficult to germinate under laboratory conditions. Justice (1941), one of the first to work on seed germination of Polygonum, concluded that dormancy in most species could be broken by scarification and chilling the seeds at 2-4 C. Timsen (1966) found that germination following cold storage treatment and de-apexing was enhanced if solutions of gibberellic acid (GA), thymine, guanine, adenine, uracil, thiourea, or cytosine were used. He found that the best germination occurred using solutions of 75 ppm gibberellic acid, 10^{-4} thymine, 10^{-4} guanine, 10^{-4} uracil, 10^{-3} adenine, or 0.13 M thiourea. In my earlier work 75 ppm gibberellic acid was found to be superior to the other solutions. Therefore, in order to determine whether changes in viability (longevity) of Polygonum longistylum L. was a monthly, seasonal, or yearly phenomenon, gibberellic acid, de-apexing, and cold storage techniques were used.

MATERIALS AND METHODS

Seed Source

Seeds for the experiment were collected by Dr. James S. Wilson, Ray Weatherholt, and myself. I collected set 1 on August 15, 1969, 6 miles west of Emporia, Kansas, on Highway 50 in Lyon County. The 2nd and 3rd sets were collected in Emporia by Wilson (15376) on October 2, 1968, at Gibson's Shopping Center and (13013) on September 27, 1967, by the Industrial Highway and 15th Avenue. The 4th and 5th sets were collected by Ray Weatherholt on October 15, 1966, at Married Student Housing (K.S.T.C.) in Emporia and in October 1966, in Anderson County close to Westphalia, Kansas.

Germination Tests

Every month 80 seeds from each set were subjected to the following experimental conditions. The seeds* in each set were subjected to a 4 hour cold storage (4 C); half of these were then de-apexed. These seeds were placed in petri dishes half-filled with white sand and treated as follows: the 1st dish had 20 whole seeds and distilled water, the 2nd 20 whole seeds and 75 ppm gibberellic acid, the 3rd 20 de-apexed seeds and distilled water, and the 4th 20 de-apexed seeds and 75 ppm gibberellic acid.

* Incompletely formed seeds that crushed easily were not used.

Controls

To determine whether seed dormancy was due to either (or both) gibberellic acid or de-apexing, two controls were used for each. Control dishes 1 (distilled water and entire seeds) and 2 (75 ppm gibberellic acid and entire seeds) were used to test the significance of de-apexing for germination in experimental dishes 3 (distilled water and de-apexed seeds) and 4 (75 ppm GA and de-apexed seeds) respectively. Control dishes 1 and 3 were used to test the significance of using gibberellic acid rather than distilled water for germination in experimental dishes 2 and 4 respectively.

Germination Dates

The germination dishes were set up on the 15th of each month. Viability tests of the seeds collected in 1969 started August 15, 1969, and ended June 15, 1970, whereas those of 1968, 1967, and 1966 began January 15, 1969, and ended January 15, 1970.

RESULTS AND DISCUSSION

De-apexing

There was no germination in the seeds that had not been de-apexed. This would suggest that there is a mechanical restriction by the paricarp and that this may be a major deterrent (in the natural environment) of early germination.

Gibberellic Acid

Germination was, as expected, considerably higher in de-apexed seeds grown in gibberellic acid. When t-tests were used to compare germination differences between GA and distilled water in de-apexed seeds collected in 1969, 1966[a], and 1966[b], differences were found to be significant at the 1% level; the difference in germination between seeds collected in 1968 was significant at the 5% level (TABLE II). The greatest average difference in germination was found in 1969 seeds which had approximately 70% germination using GA and 45% using distilled water. Germination differences using GA and distilled water in 1968 seeds was 50% and 35% respectively, and 25% and 10% was characteristic in 1966[b] de-apexed seeds. This would suggest as Nickell (1969) pointed out that GA possibly functioned in stimulation of hydrolytic enzyme systems within the seed which provided specific monomers required for embryo respiration and growth. Supplying the seed with the nitrogen base was suspected to have stimulated hydrolytic enzyme action, or alternatively, to have by-passed the need for enzymatic hydrolysis which supplied these compounds to the embryo.

TABLE I. Monthly seed germination (left column) of 20 de-apexed Polygonum longistylum seeds treated with 75 ppm gibberellic acid or distilled water (control) shown in parenthesis.

	1969[a]	1968[a]	1967[a]	1966[a] M.S. Housing	1966[a] An. Country
Jan 69		19(10)	5(4)	10(5)	5(0)
Feb 69		14(8)	7(7)	11(5)	9(1)
Mar 69		15(9)	6(6)	9(6)	6(3)
Apr 69		17(10)	6(5)	10(7)	6(2)
May 69		10(14)	4(9)	6(9)	4(2)
Jun 69		14(8)	4(5)	16(5)	4(1)
Jul 69		12(6)	4(4)	10(5)	5(3)
Aug 69	17(10)	10(5)	4(3)	8(6)	3(3)
Sep 69	15(11)	6(6)	2(3)	7(5)	5(0)
Oct 69	14(9)	6(5)	2(2)	7(6)	4(3)
Nov 69	15(11)	4(4)	2(1)	9(6)	4(2)
Dec 69	14(9)	4(3)	3(1)	8(7)	3(2)
Jan 70	10(10)	5(4)	2(2)	9(5)	4(3)
Feb 70	15(8)				
Mar 70	17(8)				
Apr 70	12(7)				
May 70	14(9)				
Jun 70	15(10)				

a The year seeds were collected.

TABLE II. Average germination (± SE) of 20 de-apexed P. longistylum seeds in 75 ppm gibberellic acid or distilled water (control), also degrees of freedom, t-test values, and confidence levels.

Seed sets	75 ppm gibberellic acid	Distilled water	Degrees of freedom	t-test	Con. level
69	14.36 ± 0.61	9.27 ± 0.30	20	7.09	0.01
68	10.46 ± 1.43	7.08 ± 0.87	24	2.06	0.05
67	4.00 ± 0.66	3.92 ± 0.47	24	0.09	
66[a]	9.23 ± 0.69	5.92 ± 0.33	24	4.33	0.01
66[b]	4.85 ± 0.44	1.92 ± 0.31	24	5.47	0.01

a Seeds collected at Married Student Housing (K.S.T.C.).
b Seeds collected in Anderson County.

Monthly and Seasonal Viability Using Gibberellic Acid

Changes in seed viability did not appear to be based on a monthly or seasonal cycle if de-apexing and gibberellic acid were used. Germination rate using gibberellic acid was essentially uniform in the 1969, 1967, and both 1966 seed sets (TABLE I). Germination remained at approximately the 70% level in 1969 seeds whereas the 1967, 1966 (college housing), and 1966 (Anderson County) seeds germinated at the 25%, 50%, and 25% level respectively.

Seeds approximately 18 months old showed a sharp decrease in viability. In September 1969, the germination level for 1968 seeds decreased from 70% to almost 30%. Since Polygonum longistylum seeds retained nearly maximum viability for almost

18 months, this would afford the species high germination during the subsequent two springs. This generally supported Justices' (1941) work who found similar results.

It is hypothesized that the P. longistylum seeds 18 months old have reached a period of lowered viability. The work begun by Beal and continued by Darlington (Darlington, 1922, 1931) demonstrated that viability in Polygonum seeds decreases at approximately 18 months and that some of the remaining seeds retain their viability for up to 50 years or more. There can be two explanations for this. The first involves seed size and amount of stored food. Smaller seeds probably contain less endosperm which could lead to a shorter maximum viability period assuming that the embryo does not decrease in size with the seed. This could be tested by subjecting weighed seeds to similar germination procedures. The second hypothesis involves the possibility that the seeds may be different genetically thus allowing a small proportion of the seeds a longer viability period.

Cold Storage

Seeds stored at 4 C were at least 20% more viable than those stored at room temperature. Forty-five per cent viability was characteristic of college housing seeds (1966), stored at 4 C in a refrigerator for 2 years, while 1967 and 1966 (Anderson County) seeds, which were stored at room temperature, germinated at the 20% and 25% level respectively.

The increase and decrease of seed viability has been considered by Mayer and Poljakoff-Mayber (1963) to be due to certain physiological changes that occur in Polygonum seeds during storage at room temperature. Seed content of sugars, amino acids, inorganic phosphate, starch, and insoluble protein was shown to vary with age in certain species of clover and rye (Ching and Schoolcraft, 1968). Likewise, relative concentrations of germination inhibitors and stimulators in seeds were shown to change during storage (Luckwill, 1952). It is not known exactly what physiological changes occurred in the P. longistylum during storage; however, the low temperature most probably functioned in reducing seed metabolism.

Yearly Changes in Seed Viability

Seed viability decreased with age. When average yearly germination (of de-apexed seeds in GA) for years 1969, 1968, 1967, 1966[a], and 1966[b] was compared to each other, the differences were significant at the 1% level except between the years 1969 and 1968 where the significance was 5% (TABLE III). However, the t-test values for test condition 4 (de-apexed seeds and GA) were not significant between the years 1968 and 1966[a]. The fact that the 1966[a] seeds were kept under continuous cold storage probably accounted for its higher germination rate when compared to the other groups.

This study has lead me to believe that P. longistylum seed viability may consist of two phases. The 1st phase is approximately an 18 month period of high viability (70% germination) followed by an extended period of lowered germination (app. 20%). The P. longistylum species can benefit two ways from this cycle. First, the long period of low viability would increase the chances of survival for the species over long periods of adverse environmental conditions and secondly, it would allow it to propagate itself quickly as a weed on newly disturbed soils as seeds would always be able to germinate when conditions were favorable.

TABLE III. The t-test values* of yearly germination of de-apexed P. longistylum seeds in 75 ppm gibberellic acid; distilled water (control) shown in parenthesis.

	68	67	66[a]	66[b]
69	2.36[e] (2.18[e])	13.76[c] (6.58[c])	5.48[c] (6.67[c])	13.00[c] (15.09[c])
68		4.35[c] (2.83[c])	0.78 (1.25)	3.77[c] (5.61[c])
67			6.34[c] (2.61[d])	1.43 (2.85[c])
66[a]				5.37[c] (8.85[c])

* The values involving the year 1969 have a degrees of freedom equal to 22, while all other values are 24.
a Seeds collected at Married Student Housing (K.S.T.C.).
b Seeds collected in Anderson County.
c Significant at the 1% confidence level.
d Significant at the 2% level.
e Significant at the 5% level.

SUMMARY

Scarification by removal of the apex of Polygonum longistylum seeds was found to be necessary for germination under laboratory conditions. It is proposed that the paricarp imparts a mechanical restriction that may be a major deterrent of germination.

De-apexed seeds grown in a 75 ppm gibberellic acid solution germinated at a higher rate than those grown in distilled water. The nitrogen base might serve to initiate or by-pass certain hydrolytic enzyme systems normally required before germination can occur.

Seeds stored at 4 C retained a higher viability than those stored at room temperature. It was thought that seed metabolism was reduced by cold storage techniques.

It was proposed that viability of Polygonum longistylum seeds may be based on a two-part cycle. The first phase of the cycle is approximately an 18 month period of high viability. The 2nd phase is a period of lower seed viability that takes place after a rapid drop in germination rate. This period of low viability can last up to 50 years or more.

Seed viability (using GA and de-apexing) in the 1st phase of the two-part cycle can be expected at 70% while 30% germination is characteristic of seeds 18 to 48 months old.

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