

# Effects of Cultivating Climate on the Phenology of a Very Rare *Sophora Flavescens* Solander

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**Abstract:-** In the case of cultivated plants, the phenomenon of plant development depends on air temperature and precipitation, and climatic parameters respond to plant phenomena. Therefore, the study of vegetative phenomena focuses on specific stages of regeneration, leaf decay, budding, flowering, end of flowering, fruit ripening and decay, and they are studied in relation to climate change and the duration of each stage of development varies. It is believed that the duration of plant growth is related to air temperature and precipitation. The study materials were selected from the seeds of *Sophora flavescens* Solander, a very rare, medicinal and edible Solander collected from Gurvanzagal soum, Dornod province in 2010. grown. The plant has a lifespan of 72% since planting and began flowering in the third year. 2017, and bean seed ripening in 2018, indicating that the plant is adapting to ex situ conditions. To study the average air temperature and precipitation of 2017-2020 and to determine the time from regeneration to leaf decay, the duration of growth, the duration of flowering, and the time of ripening of beans, the duration of growth is 119-123 days and the number of days with flowers is 18. -35 days, the number of days of soybean ripening was 20-28 days, the period of intensive growth was 35-52 days.

**Keywords:-** Average Air Temperature, Sum of Precipitation, Regeneration, Leaf Decay, Flowering, Abrasion, Decay.

## I. INTRODUCTION

*Sophora Flavescens* Solander. is a leader of the genus Fabaceae L. [1] This species has 52 species, 9 varieties and 7 different forms. It is widespread in the Asia-Pacific islands. [2] 2000 years ago, *Sophora flavescens* Solander was used in traditional Chinese medicine from the Qin and Han dynasties to treat fever, dysentery, hematopoiesis, jaundice, oliguria, edema, asthma, eczema, and inflammatory diseases. It is still widely used in the treatment of diseases such as wounds and skin burns. The plant contains more than 200 chemical compounds, the main components of which are alkaloids and flavonoids. [3] Biologically active compounds have sedative, depressant, anticancer, antipyretic, and cardiotoxic effects [4,5] and compounds such as the quinolizidine alkaloids matrin (MT) and oxymatrin (OMT) indicate hepatitis B virus (HBV) activity. Another alkaloid, Oxysophocarpine (OSC), inhibits a dose-dependent biosynthesis of leukotrienes (LTC4 and LTB4) [7]. It is a rare medicinal plant and contains endophytes in its soil. This affects the growth of the host plant in years of drought and water scarcity, increasing the plant's surface biomass. [3] The use of natural alkaloids in the production of medicines is increasing. Therefore, in order to protect the gene pool of the very rare medicinal plant, the *Sophora flavescens* Solander, and to study the possibility of the biotechnological plant to adapt to the ex situ environment, it was necessary to observe the plants from the spring to the autumn. The purpose is to determine the effect of air temperature and precipitation on the duration of flowering and fruit ripening in beans.

### Research Site:

The experiment was conducted in the Botanical Garden of the institute of Botanical Garden of the Mongolian Academy of Sciences. The site is located at an altitude of 1580 meters above sea level in the 12th khoroo of Bayanzurkh district of Ulaanbaatar. The area of medicinal plants is located between 10°05'56.7" south latitude and 47°54'35.9" north latitude.



Figure 1. General area of the Botanical Garden

**Plant material**

*Sophora flavescens* Solander is a rare plant listed in the Mongolian Red Data Book that is endangered due to low resources, drought, overgrazing, and large-scale illegal harvesting of the upper and lower parts of the land for medicinal purposes [22]. It has been concluded that biotechnological propagation is necessary because the percentage of natural plant seeds is low or less than 50% [5]. Therefore, in 2010, the seeds of *Sophora flavescens* Solander, a very rare medicinal plant collected from nature

in Gurvanzagal soum, Dornod province, were grown by M. Tsolmon, a researcher at the Institute of Biology of the Mongolian Academy of Sciences. The plant was planted in ex situ conditions in September 2014 in the medicinal plant area of the Botanical Garden, an experimental research area of the introduction laboratory in the plant gene pool of the Botanical Garden of the Mongolian Academy of Sciences. The plant survival rate was 72 percent, and 10 individuals grown in ex situ conditions began to bloom in the third year, in 2017, so they were selected based on research materials.



Figure 2. Growing in the Botanical Garden *Sophora flavescens* Solander.

**II. PHENOMENAL METHODOLOGY**

Phenomenological observations are carried out from spring regeneration to decay, shoot formation, budding, flowering root, maturation, termination, fertilization, seed maturation, and topsoil decay using in Beideman's (1960) methodology. In the reproductive organs marked the period of growth, the beginning of leaf decay, the period when the

growth of shoots stops, the leaves reach normal size, the leaves turn yellow: the formation of buds, the beginning of flowering (20%) -, the peak flowering (50%), the end of flowering (30%) The period of formation and ripening of fruit beans was observed once every 3 days. Numerical data were collected and observed in 10 individual plants for the duration of growth from the beginning of plant regeneration to yellowing of leaves, the duration of flowering from the

beginning of flowering to the end of flowering, and the period of ripening of fruits and beans from seed to full maturity. [18,19,20]

Meteorological indicators for 2017-2019 are based on data from the Amgalan Meteorological Station in the Botanical Garden, while the meteorological indicators for 2020 are based on data from the Tolgoit Station in Ulaanbaatar [13].

Statistic analyzis

The *Sophora flavescens* Solander. 2017-2020 visual observation data were replaced by a continuous table, and the outline statistics, such as averages, standard deviations, and standard errors, were developed in Microsoft Excel 2013 according to the methodology [22].

Equation 1. Average

$$M = \frac{EV}{n}$$

Equation 2. Standard deviation

$$\sigma = \sqrt{\frac{c}{n-1}}$$

Equation 3. Standard Error

$$m = \frac{\sigma}{\sqrt{n}}$$

Note:

M is the mean value, EV is the sum of the total repetitions, n is the number of repetitions, c is the variance value,  $\sigma$  is the standard deviation, m is the standard error

In order to express the phenomenon in the phenospector, laboratory of plant introduction and genetic resource of the institute of Botanical Garden of the Mongolian Academy of Sciences was mapped in Paint using the basic methodology. In preparing the climate diagram, the weather indicators for 2017-2020, such as air temperature on average for 1 month and precipitation for 1 month, were calculated [13] and a graph was created in microsoft excel 2013.

III. RESULTS

In the climatic diagram of the weather, it was dry from the first ten days of April 2017 to the second ten days of May, and in the middle of the second ten days of April 2018 to the first ten days of June. The amount of precipitation was insufficient dryness processed. No drought was observed in 2019. In 2020, there will be a drought from the first ten days of April to the third ten days of May. The annual air temperature for the years of the study allowed the plants to grow above + 10.5°C. Cultivated *Sophora flavescens* Solander.

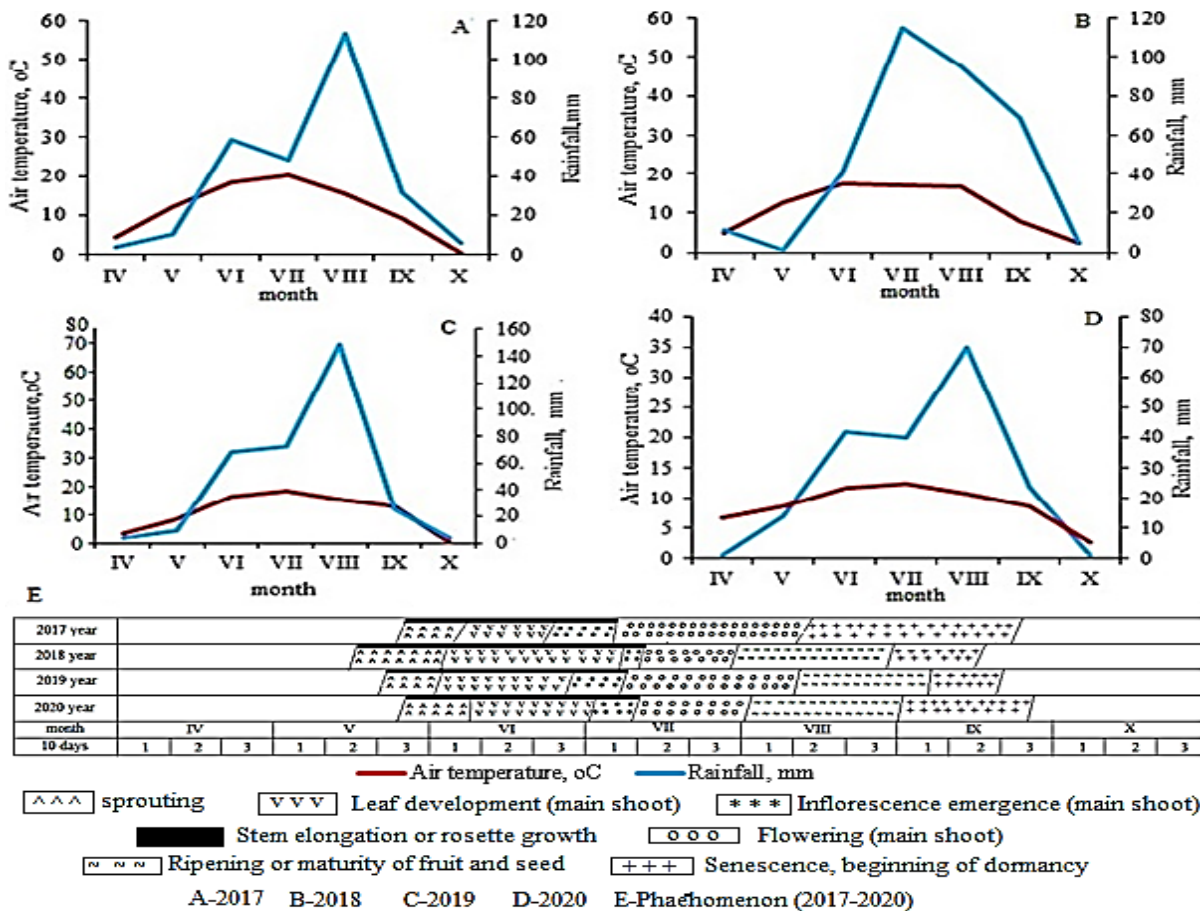


Figure 1. Climate diagrams and phenomena of *Sophora flavescens* Solander (April-October months)

In April 2017, when the plants were calm, the average air temperature was 4.5°C and the sum of precipitation was 3.4 mm. At the end of the third decade of May, when the plants were recovering, the average air temperature was 12°C and the total precipitation was 10 mm. From the first ten days of June to the end of June 3, the average air temperature was 18.5°C and the total precipitation was 58.5 mm. From the beginning of flowering to the end of July, the first ten days of July. From the day to the middle of the second decade of July, the average air temperature was 20.2°C and the total amount of precipitation was 48.2 mm. The plant did not ripen in 2017. After flowering, the average air temperature was 15°C and the total precipitation was 113.5 mm. The period of complete yellowing of leaves was at the beginning of the 2nd decade of September, when the average air temperature was 9.1°C and the sum of precipitation was 31.7 mm, and when the plant was at rest, the air temperature was 0.3°C and the sum of precipitation was 5.8 mm.

In April 2018, when the plants were at rest, the average air temperature was 4.96°C and the total amount of precipitation was 11.6 mm, while the period of plant recovery began in the second half of May with an average air temperature of 12.7°C and the sum of precipitation. It was 1.3 mm. The period from the beginning of leaf decay to the end of leaf decay lasted from the beginning of the 1st decade of June to the end of the 3rd decade of June. During this period, the average air temperature was 17°C and the total precipitation was 39.8 mm. It started flowering on the first ten days of July and ended in full bloom at the end of the third ten days of July. At this time, the average air temperature was 17.1°C and the total precipitation was 115.3 mm. The ripening of beans lasted from the end of the first decade of August to the end of the third decade of August. During this period, the average air temperature was 16.8°C and the total precipitation was 95.1 mm. From the end of the first decade of September to the middle of the second decade of September, the leaves of the plant turn yellow and completely decay. At that time, the average air temperature was 7.8°C and the total precipitation was 68.8 mm. In October, when the plants were dormant, the average air temperature was 2.3°C and the total precipitation was 4.5 mm.

In April 2019, when the plants were at rest, the average air temperature was 3.2°C and the sum of precipitation was 4.1 mm, while at the beginning of the plant's recovery period, at the beginning of the 3rd decade of May, the average air temperature was 12.5°C and the sum of precipitation was 8.7 mm. The period from the beginning of leaf decay to the end of leaf decay lasted from the beginning of the 1st decade of June to the middle of the 2nd decade of June. During this period, the average air temperature was 15.9°C and the total precipitation was 4.5 mm. From the beginning of flowering to the end of flowering lasted from mid-July to the end of the first decade of August. During this period, the average air temperature was 18.2°C and the

total precipitation was 171.1 mm. Fruits and beans ripen from mid-August to mid-September to mid-September. At that time, the average air temperature was 14.2°C and the total precipitation was 72.9 mm. The leaves of the plant began to turn yellow in the middle of the second decade of September, and at the end of the second decade of September completely decomposed. At that time, the average air temperature was 11.9°C and the sum of precipitation was 1.7 mm. The average air temperature was 0.5°C and the sum of precipitation was 4.1 mm when the plants calmed down.

In April 2020, when the vegetation was calm, the average air temperature was 6.18°C and the total precipitation was 4.4 mm. It began to recover in the middle of the third decade of May. During this period, the average air temperature was 10.6°C and the total precipitation was 11.8 mm. The period from the beginning of leaf decay to the end of leaf decay lasted from the middle of the first decade of June to the end of the second decade of June. At that time, the average air temperature was 17°C and the total precipitation was 46 mm. The period from the beginning of flowering to the end of flowering lasted from the beginning of the first decade of July to the end of the third decade of July. During this period, the average air temperature was 19.08°C and the total precipitation was 93.2 mm. Fruits and beans began to ripen in the beginning of the first decade of August, and fully ripened in the end of the third decade of August. At that time, the average air temperature was 16.5°C and the total precipitation was 88.9 mm. From the end of the first decade of September, the leaves turn yellow and completely wither in the middle of the third decade of September. During this period, the average air temperature was 11.4°C and the total precipitation was 38 mm. The average air temperature was -0.008°C and the total precipitation was 10.7 mm when the plants moved to calm.

For *Sophora flavescens* Solander, very rare grown in the Botanical Garden of the Mongolian Academy of Sciences, to observed the timing of the transition from one stage to another varies depending on the average temperature and the sum of precipitation during the study years .

By studying the period of spring regeneration, leafing, budding, flowering, fruit and ripening, leaf and decay in very rare natural herbaceous plants, it is possible to effectively solve the problem of processing and rational use of medicinal plant raw materials, protection and reproduction of gene pool.

The phenomenological stages of the plant grow at different times for 4 consecutive years. In the future, it is possible to conduct surveys for many years in a row and study the phenomena that have a strong impact on the growth of plants in a given year and their recurrence, which can reveal the process of plant adaptation to climate change.

| Year | 2017 year |       |                | 2018 year |       |                | 2019 year |       |                | 2020 year |       |                |
|------|-----------|-------|----------------|-----------|-------|----------------|-----------|-------|----------------|-----------|-------|----------------|
|      | Phases    | Mean  | Standard Error | SDEV.S    | Mean  | Standard Error | SDEV.S    | Mean  | Standard Error | SDEV.S    | Mean  | Standard Error |
| V1   | V.26      | 1.528 | 4.83           | V.15      | 1.189 | 3.7565         | V.21      | 1.067 | 3.373          | V.25      | 1.432 | 4.525          |
| V2   | VI.06     | 1.528 | 4.83           | VI.02     | 4.546 | 14.367         | VI.01     | 1.681 | 5.314          | VI.07     | 0.441 | 1.394          |
| V3   | VI.22     | 1.467 | 4.638          | VI.29     | 0.917 | 2.8983         | VI.16     | 1.067 | 3.373          | VI.17     | 1.165 | 3.681          |
| R1   | VII.05    | 1.375 | 4.347          | VII.06    | 0.306 | 0.9661         | VI.23     | 1.834 | 5.797          | VII.01    | 1.134 | 3.583          |
| R2   | VII.13    | 1.222 | 3.864          | VII.10    | 1.223 | 3.8644         | VII.06    | 2.14  | 6.763          | VII.10    | 0.493 | 1.558          |
| R3   | VII.26    | 2.75  | 8.695          | VII.19    | 1.223 | 3.8644         | VII.23    | 2.904 | 9.178          | VII.22    | 1.853 | 5.855          |
| R4   | VIII.15   | 1.528 | 4.83           | VII.28    | 1.07  | 3.3813         | VIII.10   | 0.534 | 1.687          | VII.30    | 0.132 | 0.417          |
| R5   | -         | 1.833 | 5.797          | VIII.08   | 1.987 | 6.2796         | VIII.14   | 1.223 | 3.864          | VIII.03   | 2.643 | 8.352          |
| R6   | -         | 0.9   | 2.846          | VIII.28   | 2.599 | 8.2118         | IX.06     | 2.802 | 8.854          | VIII.31   | 1.934 | 6.111          |
| S1   | IX.12     | 0.667 | 2.108          | IX.08     | 0.917 | 2.8983         | IX.14     | 0.611 | 1.932          | IX.09     | 0.369 | 1.166          |
| S2   | IX.22     | 0.667 | 2.108          | IX.15     | 1.07  | 3.3813         | IX.20     | 0.917 | 2.898          | IX.25     | 1.215 | 3.839          |

Table1. growing season of *Sophora flavescens* Solander.

Note: V1-Vegataive growing stages R-Reproductive growing stages S-Senescence V1-revival V2-leaf decay V3-finish to leaf decay R1-bud R2-flowering start R3 flowering peak R4-flowering end R5-bean ripening start R6-Fully ripe beans S1-start rot S2-end

The duration of plant growth in the Botanical Garden is 4-10 months. In 2017, the average air temperature was 11.4°C and the sum of precipitation was 271.1 mm, in 2018 the sum of average air temperature and 11.2°C was 336.4 mm, and in 2019 the sum of air temperature was 10.75°C and the sum of precipitation was 331.7 mm, in 2020 the average air temperature was 11.6°C and the sum of precipitation was 279.7 mm. In 2017, the duration of plant growth was 119 days, the period of intensive growth was 40 days, and the number of days of flowering was 33 days. The beans did not ripen that year. In 2018, the duration of growth is 122 days, the period of rapid growth is 52 days, the number of days with flowers is 18 days, and the number of days of fruit ripening in beans is 20 days. In 2019, the duration of plant growth will be 122 days, the period of intensive growth will be 33 days, the number of days with flowers will be 35 days, and the number of days for fruit and legumes will be 23 days. In 2020, the duration of plant growth is 123 days, the period of intensive growth is 39 days, the number of days with flowers is 20 days, and the period of fruit ripening in beans is 28 days.

In 2017 and 2020, the average air temperature for the growing season of the year was 11.4°C-11.6°C, which may have extended the flowering period. Also, the total amount of precipitation is between 271.1-279.7 mm, which shows that the climate of those years is similar. The average air temperature during the growing season of 2018-2019 decreased by 0.2°C-0.5°C compared to 2017,2020, and the total precipitation increased by 52-65 mm, which may be due to the high rainfall during flowering and fruit bean ripening.

#### IV. DISCUSSION

The *Sophora flavescens* Solander, grows in light, fertile soils away from direct sunlight and is a cold tolerant of -15°C. [15] The roots of the plant live in symbiosis with some soil bacteria resistant to soil fungi. Increases soil mineral content with nitrogen. [14] Due to the fact that the ability of seeds to grow in nature is less than 50%, it is suitable for biotechnological callus formation and growing in vitro. symbiosis with soil bacteria creates a life form. [12] The chemical composition of the *Sophora flavescens* Solander has been studied to determine if the seeds contain galactomannan. In the study of the carbohydrate content of seeds, 30 g of powdered seeds contained glucose, galactose and sucrose in a ratio of 1: 5: 1. Pectin with ether containing galutamine accounted for 10.3%. [18] The plant contains mainly alkaloids, glycosides in the leaves, vitamin C and essential oils in the flowers. After sowing the seeds in 80% sulfuric acid for 30 minutes, the germination rate increases as the temperature of the seeds increases. The optimum temperature for germination is 30°C for 40 minutes. [17] Blonde leader *Sophora flavescens* Solander. It emerges in late April and early May, [11] blooms in June and begins to bloom in July. [12] Based on the 2010 Nagoya Protocol to the Convention on the Conservation and Rational Use of Biological Diversity, plant resources continue to be misused around the world. For example, *Sophora flavescens* Solander, a regional leader, uses the plant's root extract in traditional medicine, which has been widely used in Oriental hospitals to treat some internal ailments and to relieve fever and sedation. is a very rare plant that is endangered by the red list. Therefore, over time, it has a negative impact on the environment and vegetation. This study is unique in that it protects the genetic resources of very rare plants and cultivates them in ex-situ conditions grown by biotechnological methods.

## V. CONCLUSION

*Sophora flavescens* Solander. of grown in ex situ conditions in the Botanical Garden, has a spring regeneration of V.15 to V.27 due to the average air temperature and the sum of precipitation, while the vegetation period ends between IX.15 and IX.25. It varies from 5 to 12 days.

The period of intensive growth of cultivated plants was 35-52 days, the duration of growth was 119-123 days, the period of flowering was 18-35 days, and the period of ripening of fruits and beans was 20-28 days.

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