THE STUDY ON THE EFFECT OF LIGHT TO THE DEVELOPMENT AND GROWTH OF SESBANIA (AEGYPTIACA, PERS.) SESBAN, MERR.

by

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I. INTRODUCTION

Sesbania is a genus belonging to the family Leguminosae and sub-family Papilionaceace, consisting of about 20 species of both annual and perennial plants, and distributing over the old world tropics from Himalaya, Ceylon, Siam and eastward to the southern part of Formosa. While Formosa, being for the most part a sub-tropical country, is a marginal territory of its natural distribution.

The botanical characters of the species S. sesban, Merr.

According to Dr. E. D. Merrill. that S. sesban is a small tree or shrub of 6–15 ft. tall, with 21–41 glabrous, linear oblong, obtuse mucronate, and abruptly pinnated leaf-lets; flowers 6–10 in copious lax axillary racemes; pedicels filiform 1/6–1/4 inch; Calyx glabrous membranaceous, short teethed, deltoid; Corolla 1/2–3/4 inch, glabrous, pale yellow purple, more or less tinged with deep red; petals with long claws, standard broad, keel obtuse, straight or recurved and subrostrate; Stamens diadelphous; Anthers uniform; Ovary linear, stipitate, many-ovuled; Style filiform, incurved, glabrous; Stigima capitate; Pod 6–9 inches long twisted and pendulous, narrow dehiscent, with distinct septa between the very numerous seeds, and sutures little thickened.

This plant has a very important economic value in its marvellous fast growth in wood and especially fast during the first two years. Its fast growing character in wood may be utilized and artificially cultivated by using technical management of forest planting with an object of producing wood making charcoals, which are of great demand in the markets of Taiwan.

The limiting factor of distribution of a tropical plant to a sub-tropical country is mainly the problem of photoperiodicity, i. e. the light intensity and light duration, therefore the object of this study is the effect of density of stockings and the day-length on the development and growth of the plant.

II. THE STUDY ON THE EFFECTS OF LIGHT TO THE RATE OF GROWTH IN HEIGHT AND IN DIAMETERS PER UNIT AREA OF 10 SQAURE METERS OF LAND

A. The effects of density of stockings on the rate of growth:

1. Materials.

3 beds of 2.5×4 meters each, with well prepared garden silty soils, without fertilizer, no watering.

100 selected seeds of Sesbania sesban, collected from Tainan planted in each bed.

2. Method.
   (1) Seeds were sown in the garden of the National Taiwan University on 22nd of May 1955.
   (2) 3 beds of equal sizes were made side by side for comparison of growth.
   (3) The spaces between rows and individual stockings were 60 cm. for the first bed, 20 cm. for the second, and 30 cm. for the third bed.
   (4) Two isolated trees were planted 2 meters away from the 3 beds.
   (5) Examination and measurements of the development and growths began 5 months after seeding.
   (6) The measurements were taken once in approximately every 3 months.
   (7) The total period of time of growth measured was one and half a year, while in both height and diameter were nearly ceased. (See figure 1, 2, 3, 4)
3. Results obtained.

Table 1. The average height and diameter growths.

Date of Measurement taken on	Number of trees existed in bed.	Average height growths in M.	Average Diam. in cm. at base.
The first Bed:			
1955/10/26	31	3.60	9.0
1956/1/6	31	4.37	10.0
1956/4/10	26	4.70	13.0
1956/6/25	23	5.45	16.0
1956/9/22	21	6.05	20.0
1956/11/22	14	6.45	22.0
The Ave. Monthly growths	—	0.22	1.0
Second bed			
1955/10/26	76	2.60	5.00
1956/1/6	75	3.50	8.00
1956/4/10	68	3.80	10.00
1956/6/25	42	4.65	13.00
1956/9/22	34	5.47	16.00
1956/11/22	18	5.75	17.00
The Ave. Monthly growths.	—	0.24	0.90
Third bed			
1955/10/26	47	1.85	3.00
1956/1/6	47	2.80	6.00
1956/4/10	33	3.20	9.00
1956/6/25	24	3.95	10.00
1956/9/22	18	4.50	12.00
1956/11/22	11	4.60	13.00
Ave. Monthly growth.	—	0.21	1.20

The isolated trees			
1955/5/25	2	4.65	21.00
1956/9/22	2	5.30	28.00
1956/11/22	2	6.28	31.00
1956/3/17	2	6.60	32.00
The average monthly growths	—	0.21	1.20

Table 2. The average height and diameter growth and the average amount of wood produced per tree in weight.

Bed No.	No. of trees left when harvested	Ave. Ht. growth in meters.	Ave. Dia. Growth in cm. at base.	Ave. Wt. per tree	Total Wt.
I.	14	6.5m.	28.0cm.	20.0kgrs.	280.0kgrs.
II.	18	5.8	20.0	14.0	252.0
III.	11	4.7	16.0	12.0	132.0
Total ave.	143	5.6	21.3	15.5	221.0
Isolated tree	2	6.5	39.0	28.0	56.0

4. Discussion.

From the above two tables one can readily see the effects of density of stocking on the rate of growth in height, in diameter as well as in total production of wood. Sesbania sesban, Merr. is a rather light demanding species. We can see from the table B. that the denser the stocks are, as in bed No. III, the less the average diameter growth and consequently the smaller the amount of wood produced per unit bed, but in general the more densely stocked stand has less diameter growth and more height growth. Whereas in this case it was not so, which may be due to the fact that this species was originally a shrub in nature and the density of stockings could not affect the height growth against their hereditary character of a shrub and this can also be proved by the isolated trees growing two meters away from the three beds having almost the same maximum height growth with those in the dense stands. Trees in the bed No. I, being sparcely populated, due to natural thinning out, have attained their maximum height growth, diameter growth, as well as their total wood production and that of the bed No. III, being too sparcely populated with only eleven trees left alive in the bed at the time of harvesting, have also less growth in height, in diameter, and in wood production, which indicates that both, the height and diameter growth of this species have their limit regardless of the density of stocking though the isolated trees grown larger in diameter and more wood produced, but it is impractical to plant too sparcely in economic practice of forest plantations. The maximum height growth of this species is ranging from 5.5–6.5 meters in any dense or sparce stand condition and probably it could be never over 6 meters in height. The average diameter growth measured in basal circumference is ranging from 16–28cm. in three beds and average is 21.3 cm. From the second year on the diameter growth will

increase very slowly, but the wood will become the harder and the trees will die off gradually. This species growing in Taiwan other parts of the south, its height growth is generally not more than three meters and its diameter growth is usually not more than 15 cm. in basal circumference and the plant is a shrub. When they are brought up north and planted in their border line distribution area, where the day-light duration is longer during the growing season, the growth in both, height and diameter will be highly stimulated and the rate of increase will be almost twice as much as that growing in the south, but its longevity is reduced to only 2–3 years.

The average production of wet wood is from 12–20 kilograms per tree in beds planted with a space of approximately 1×1 m. and that of the average of three beds is 15.5 kilograms. Suppose we plant 10,000 such trees with space of 1×1 m. per hectare of land and let them grow for two years, the product of wood will be 15.5×10,000= 155,000 kilograms. Each hundred kilograms of wet wood can make 30 kilograms of dry soft charcoals. The present wholesale market price of such charcoal is NT$60. per 100 kilograms. Then 155,000 divided by 100×30=46,500 kgs. charcoal and 46,500 ÷100×60=NT$ 27,900 per hectare. A rough estimation of the costs of plantation, care of the crop, manufacture of charcoals, transportations, and other miscellaneous fees would amount to NT$ 12,000 per hectare. So it is a very profitable enterprice and worthwhile to put it into practice.

B. The effects of light intensity and duration on the rate of growth of Sesbania sesban, Merr.

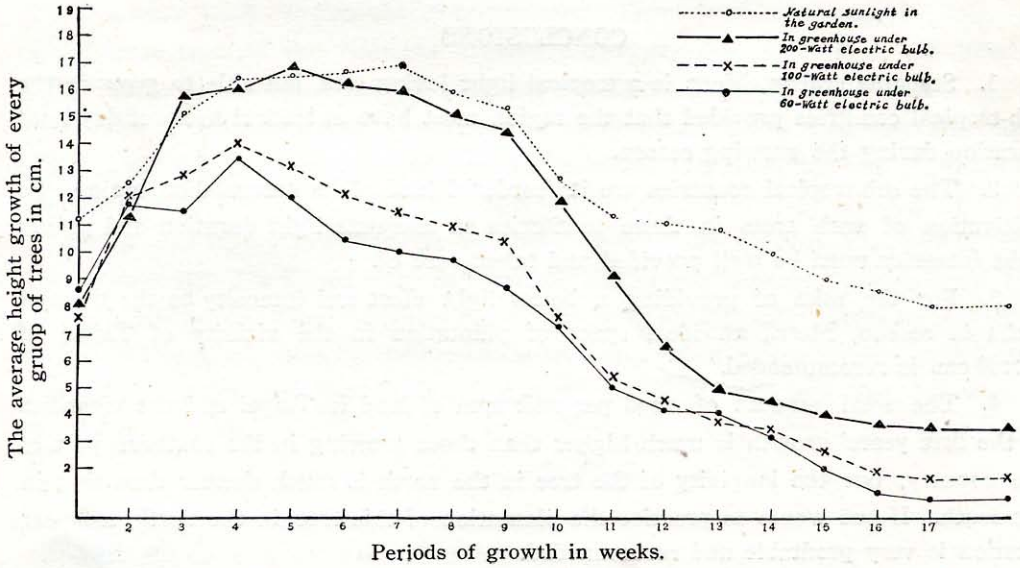
1. Materials.
   Large flower pots and garden silty soils. Present year matured seeds of Sesbania sesban, Merr., 60-Watt, 100-Watt, and 200-Watt electric bulbs.
2. Method.
   (1) Sow the seeds in prepared seed bed and raise nursery stocks.
   (2) After 10 days of growth of the stocks transfer them into flowering pots.
   (3) Plant 4 stocks in each pot.
   (4) 24 pots are divided into 4 groups and put under 4 different growing light conditions:
   a/ Under the natural light in the open garden.
   b/ In the greenhouse under natural light during the day-time and prolong the light duration of 4 hours with artificial light every day under the following different intensities:
      i/ Under 60-Watt electric bulb, 2 meters below.
      ii/ Under 100-Watt bulb, 2 meters below.
      iii/ Under 200-Watt bulb, 2 meters below.
   c/ The average growth of heights of each pot and each group are measured once in every week.
   d/ The total growth period measured are 4 months.
3. Results obtained.

Table 3. Under different light conditions, the average height growth of every group measured in cm.

Week	Natural light in open garden	In greenhouse Under 60-Watt bulb	In greenhouse Under 100-Watt bulb	In greenhouse Under 200-Watt bulb
1.	11.2	8.5	7.7	8.2
2.	12.5	11.8	12.0	11.4
3.	15.1	11.5	12.8	16.0
4.	16.5	13.5	14.0	16.2
5.	16.7	12.1	13.3	16.9
6.	16.8	10.5	12.2	16.6
7.	17.0	10.0	11.5	16.0
8.	16.0	9.7	11.0	15.2
9.	15.5	8.7	10.5	14.6
10.	12.8	7.4	7.6	12.0
11.	11.5	5.0	5.2	9.2
12.	11.2	4.3	4.5	6.0
13.	11.0	4.0	3.9	5.0
14.	10.0	3.2	3.5	4.5
15.	9.0	2.0	2.6	4.0
16.	8.7	1.0	1.9	3.8
17.	8.1	0.8	1.5	3.5
Total	219.6	124.1	135.7	179.9

Growth curves
showing

The average height growth of every 6 trees and of every group, under 4 different light intensities, of 4 months growth, in cm.



4. Discussion:

The controlling factor of distribution of a plant growing in tropical country to a sub-tropical territory, is mainly the duration of light or the day-length of the region, and the intensity of light. The former is more sensible than the latter, because during the growing season the light intensity in the tropics is pretty much similar in effect with that of the sub-tropics, and not very sensitive to plant growth, as in both, tropic and subtropics the light intensities are more than enough for plant need, but the light duration or day-length between the tropics and sub-tropics, which controls the development of budding and flowering period of plants is quite different. The experimental results plotted in the above curves showed a very clear distinction between the growth of different light durations growing in open garden under natural sun-light and those grown in the greenhouse supplying with 4-hour prolongation of artificial light under various intensities each day. Those growing under different light intensities also showed a remarkable clear distinction of height growth. The total average height growth of the 4 months in the open garden under natural sun-light being 219.6 cm. ranked the first; that under 200-Watt electric bulb, being 179.9 cm, ranked the second; that under 100-Watt, being 135.7, ranked the third; and that under 60-Watt, being 124.1, ranked the fourth, but the difference between 100-Watt and that of 60-Watt intensity is extremely small. This shows that the intensity from 100-Watt to 60-Watt is probably reaching the lowest limit of stimulation. The 200-Watt bulb has showed a greater stimulation, while in the open garden under natural sun-light the plants have produced the best results. This was because that the glass-roofs and the wallshadows of the greenhouse have cut and reduced a lots of light intensities during the day-time. This also proved that Sesbania sesban, Merr. is a light loving species and is able to be planted in sub-tropical countries.

CONCLUSIONS

1. Sesbania seaban, Merr. is a tropical light loving tree, but able to grow in the sub-tropical countries provided that the region must have at least 11 hours of day-light duration during the growing season.

3. The sub-tropical countries are its bordered land of its natural distribution. So cultivation of such trees in these territories an adequate light duration and proper light intensity must be well provided and taken care of.

3. For the sake of providing a better light effect and intensity to the trees of Sesbania sesban, Merr., an ideal space of plantation in the vicinity of Taipei of 60×60 cm. is recommanded.

4. The total product of wood per unit area of land in Taipei and the vicinities of the first years' growth is much higher than those growing in the southern part of the country, but the longivity of the tree in the north is much shorter than that in the south. If one wants to practice the plantation of this tree in the north, a 2-year rotation is very profitable and reconmanded.

Photos showing the general growth conditions of the three beds of trees.

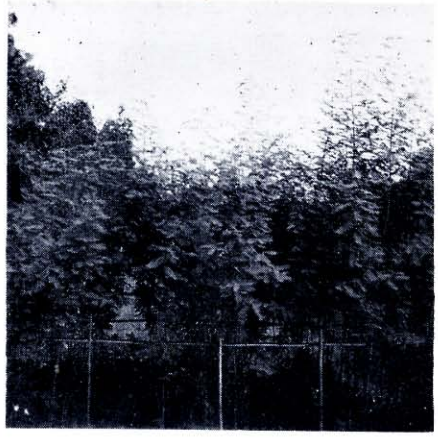


Fig. 1. Showing the comparative Ht. growth of the 3 beds, I. II. III. from right to left.

Fig. 2. The relative Diameter growth and density of trees in I. after 1½ year's growth.

Fig. 3. The relative density and diameter growth in bed No. II. after 1½ year's growth.

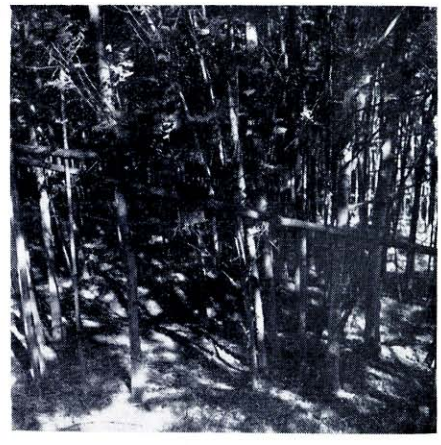


Fig. 4. The relative density & diameter growth of trees in bed No. III. after 1½ year's growth.

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