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Role of Light and Temperature in Relation to Seed Germination and Seedling Growth of *Asteracantha longifolia* Nees.

By

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With 2 Figures

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Introduction

Asteracantha longifolia NEES. is a plant inhabiting swampy areas, but grows well and completes its life-cycle mostly when water recedes, and then it takes to a terrestrial mode of life (SEN, 1961). Submerged plants do not flower, but flowering and fruiting take place when plants emerge out of water. It appears that different temperatures and light conditions might be playing some role in the ecophysiology of this plant species.

It has been reported earlier that temperature and light are important factors affecting the germination of seeds of *Ruellia tuberosa* LINN. a plant similar to *A. longifolia* (SEN and CHATTERJI, 1966). JONES and BAILEY (1956) studied the effect of light on the germination of seeds of *Lamium amplexicaule*. Red radiation has been shown to be effective in the germination of the seeds of *Verbascum Thapsus* (TOOLE et al, 1955). It was felt that a study of the ecophysiology of the family Acanthaceae might be rewarding in view of the fact that cent percent germination of the seeds of some species of this family was effected within twelve hours after imbibition when exposed to continuous white light.

Material and Methods

Fruits of *A. longifolia* were harvested locally during April—May, 1968. The fruits mature and remain on plants, as the whole plant dries when the water evaporates in the summer season from swamps in which they grow.

The seeds were immediately used for all the experimental work described herein. The seeds were germinated in petri dishes containing a single filter paper, moistened with distilled water. All germination experiments were conducted in continuous white light from two fluorescent tubes of 40 watts each fitted at a distance of one meter from the petri dishes. The different coloured lights (red and blue) were obtained by wrapping the same tubelights with standard cellophane papers of these colours. For total darkness the petri dishes were kept in dark chambers. The temperatures maintained varied from 24° to 38° C in all the light and dark conditions.

The criterion for germination was visual detection of the protrusion of the radicle. The length of radicle and hypocotyl were measured and calculations carried out with seedlings which were five days old. Like *R. tuberosa* (SEN and CHATTERJI, 1966), the seeds of *A. longifolia* produced copious mucilage when they came in contact with water.

Observations

It was observed by the authors that the germination of seeds of *A. longifolia* was primarily dependent on light and temperature. This fact was confirmed in detail by the following experiments.

(a) Effect of temperature on germination

After preliminary trials that the seeds were light sensitive and did not germinate well in total darkness, the optimum temperature for germination was found out. Part of the Table I gives the mean percentage at different temperatures in continuous illumination.

The pace of germination for five days at different temperatures have been indicated in the columnar graph (Fig. 1). The first signs of germination became evident after twelve hours. The optimum temperature at which germination to the extent of a hundred percent took place within the first twenty four hours was 28° C. A hundred percent germination was achieved within the first forty eight hours at 24° C, 26° C and 30° C, and within first twenty four hours at 28° C, but similar results could not be observed within the experimental period of five days at higher temperatures.

(b) Effect of total darkness on germination

Part of the Table I also incorporates the mean germination percentage in darkness at different temperatures. The pace of germination for five days has been indicated in the columnar graph (Fig. 1). As is evident in the graph, a hundred percent germination was not achieved at any of the temperatures during the observation period of five days.

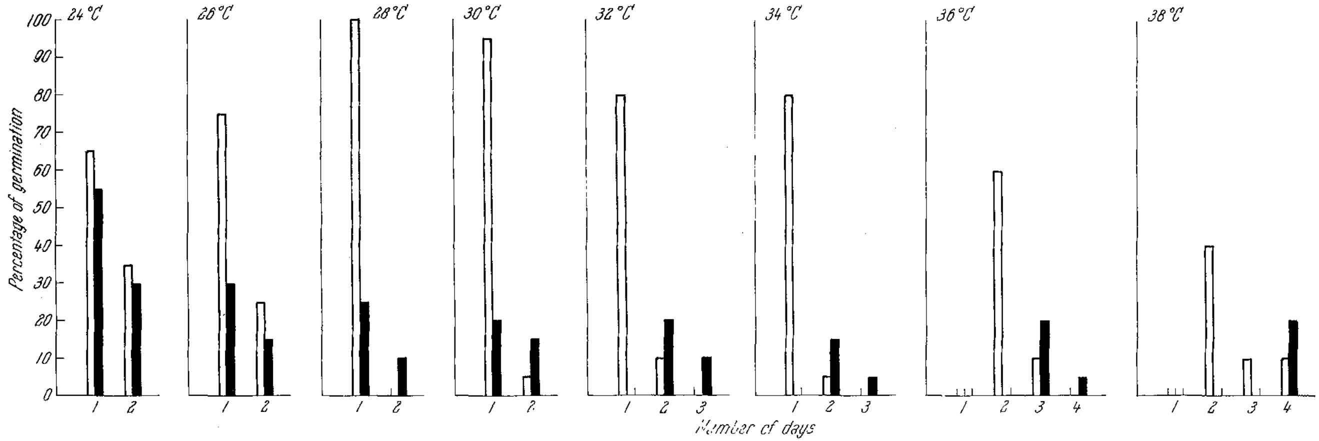

Fig. 1. Graphic representation to show the daily pace of seeds germination in *Asteracantha longifolia* Nees. at different temperatures (24° C to 38° C) in continuous white light (white column) and total darkness (black column)

Table I. Effect of light and temperature on the seed germination and seedling growth (five days old) of *Asteracantha longifolia* Nees.

	24° C		26° C		28° C		30° C		32° C		34° C		36° C		38° C	
	Li	Da	Li	Da	Li	Da	Li	Da	Li	Da	Li	Da	Li	Da	Li	Da
Germination Percentage	99.3 ± 1.7	75.0 ± 7.5	97.1 ± 4.4	41.0 ± 3.6	96.6 ± 4.5	37.1 ± 7.5	95.7 ± 4.1	34.0 ± 6.4	88.3 ± 8.5	32.5 ± 16.7	84.0 ± 5.4	28.4 ± 7.4	73.0 ± 7.5	28.0 ± 4.1	58.0 ± 12.0	23.0 ± 5.0
Hypocotyl in mm	1.7 ± 0.4	8.0 ± 0.8	2.5 ± 0.5	18.0 ± 8.0	4.7 ± 1.4	22.0 ± 10.0	4.0 ± 1.0	24.0 ± 16.0	3.5 ± 1.0	20.0 ± 5.0	3.2 ± 2.0	18.0 ± 10.0	3.0 ± 1.0	2.7 ± 0.8	2.3 ± 0.6	1.0 ± 0.1
Radicle in mm	31.4 ± 9.0	37.0 ± 15.0	47.0 ± 6.0	46.0 ± 19.0	46.0 ± 8.0	45.0 ± 4.0	41.0 ± 2.0	50.0 ± 15.0	36.0 ± 13.0	43.0 ± 19.0	34.0 ± 5.0	25.0 ± 10.0	23.0 ± 10.0	22.0 ± 8.0	16.0 ± 9.0	4.5 ± 1.0

Li = continuous white light, Da = total darkness.

The optimum temperature for total darkness was found to be 24° C at which 55 percent germination took place within the first twenty four hours after imbibition. This percentage for the first 24 hours continues to decrease with rising temperatures till 30° C. At 32° C and 34° C no germination took place within the first twenty four hours and 20 and 15 percent germination occurred in the neighbourhood of 48 hours, respectively. At 36° C and 38° C, the germination process was further delayed by 72 hours.

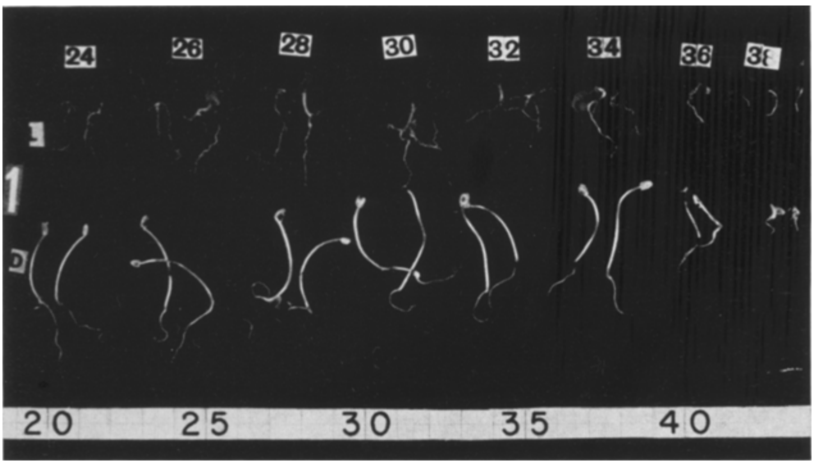

Fig. 2. Five days old seedlings of *Asteracantha longifolia* NEES. at different temperatures (24° C to 38° C) in continuous white light (*L*) and total darkness (*D*)

(c) Effect of blue and red radiations on germination

It appeared that blue or red light did not influence the germination to any marked extent. Seventy to seventy-five percent seeds germinated within the first twenty four hours and the process was complete in the following twenty four hours. Of course, germination in these lights of different colours was somewhat slower than that in white light, as in the latter, cent percent germination occurred within the first twenty four hours after imbibition.

(d) Growth of radicle and hypocotyl

The data relating to the growth of radicle and hypocotyl after five days of germination have been incorporated in Table I. The hypocotyl indicated the optimum linear growth of 4.7 $\pm$ 1.4 mm and 24.0 $\pm$ 16 mm at 28° C and 30° C, respectively in continuous white light and total darkness. But the optimum linear growth of radicle measured 47.0 ± 6.0 mm and 50.0 ± 15.0 mm at 26° C and 30° C, respectively in continuous white light and total darkness. It was concluded from these data that the hypocotyl grew six times more in total darkness as compared to the growth in white light, whereas the growth of the radicle in continuous light and darkness did not indicate much difference. The growth of the hypocotyl in total darkness also depended on a suitable temperature, e. g., this length was reduced to 1.0 ± 0.1 mm at 30° C. The radicle did not indicate the suppressed growth at 38° C in the same proportion as at 30° C in total darkness (Fig. 2).

The growth of hypocotyl and radicle in red and blue lights at optimum temperature have been recorded in Table II.

Table II. Germination percentage of seeds of *A. longifolia* and seedling growth (in mm) in red, blue, white lights and total darkness after five days of germination

Germination/Growth	Red light	Blue light	White light	Total darkness
Germination percentage	100	100	100	35
Hypocotyl length	7.0 ± 5.0	15.0 ± 5.0	4.4 ± 1.4	22.0 ± 10.0
Radicle length	32.0 ± 2.0	36.0 ± 4.0	46.0 ± 6.0	45.0 ± 4.0

It would be evident from Table II that blue light enhanced the growth of the hypocotyl more than three times as compared to that of white light, although red light was also favourable to a somewhat lesser degree. However, it appeared that red light as well as blue light had some sort of inhibitory influence on the growth of the radicle.

Discussion

A temperature regime most favourable for germination would appear to exist for seeds of different species as well as lots of seeds. It has been said that the interaction of temperature and light on seed germination would be expressed differently in different seeds (TOOLE et al., 1957). It has also been stated that temperature would act by a mechanism different from that of light, although the mechanisms themselves have so far remained unknown (KOLLER et al., 1962). The results in case of the seeds of *A. longifolia* would seem to suggest that the response as regards germination to white light and different ranges of temperature was not very different from that of the seeds of *R. tuberosa* (SEN and CHATTERJI, 1966).

The seeds of *A. longifolia* were found to germinate preferably in white light upto 100 percent at 28° C. The germination percentage reached a sufficiently high level (75 percent) at 24° C in total darkness. In other words lower temperature partly compensated for light requirement of the seeds for germination. The germination percentage of the seeds of *A. longifolia* fell to about 23 percent at 38° C in total darkness, which was in contrast with the results obtained with the seeds of *R. tuberosa* where some germination did take place but only at higher temperatures. At the same time continuous illumination did not have any influence if the temperature fell below 20° C in case of the seeds of *R. tuberosa.* But germination upto 65 percent occurred in the seeds of *A. longifolia* within the first twenty four hours at 24° C. At 36° C and also at 38° C the germination was delayed by one day in case of the seeds of *A. longifolia* as compared to those of *R. tuberosa,* where 90 and 80 percent germination occurred within first twenty four hours, respectively. JONES and BAILEY (1956) reported that the germination of non-dormant seeds of *Lamium amplexicaule* is inhibited by light. This inhibition effect of light was temporary, the length of the inhibition period depended to some extent on the intensity of light used. In total darkness the pace of germination in the seeds of *A. longifolia* decreased when exposed to temperatures beyond 38° C. Thus it appeared that total darkness and high temperature were inhibitory to germination. It would be evident from the graph that the percentage of germination within the first twenty four hours increased upto 28° C, beyond which temperature it decreased together with the pace of germination.

Blue and red lights did not have any marked different effect on germination percentage as compared to that in white light.

The growth of the hypocotyl was affected to a very great extent in continuous white light and total darkness, although the radicle remained almost unaffected in both the conditions. Temperature appeared to regulate the growth of hypocotyl in total darkness. Blue light promoted hypocotyl growth more than red light, but both these coloured lights inhibited radicle growth.

Summary

The seeds of *Asteracantha longifolia* prefer germinating in light. Germination was also favoured in blue and red lights, whereas total darkness delayed this process. The optimum temperature for germination of seeds was 29° C in continuous white light. The seeds did germinate in total darkness as well, but the percentage of germination remained poor, and with high temperatures beyond 30° C, the pace of germination became slow. Higher temperatures suppressed the seedling growth both in continuous white light and total darkness. Blue and red lights promoted hypocotyl growth, whereas radicle was inhibited.

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References

ALCORN, S. M., and E. B. KURTZ: Some factors affecting germination of seed of the Saguaro cactus (Carnegia gigantea). Amer. Jour. Bot. **46**, 525—529 (1959).

CHAWAN, D. D., and D. N. SEN: Role of some growth regulating substances on seed germination and seedling growth of Asteracantha longifolia NEES. In press.

JONES, M. B., and L. F. BAILEY: Light effects on the germination of seeds of henbit (Lamium amplexicaule). Plant Physiol. **31**, 347—349 (1956).

KOLLER, D., A. M. MAYER, A. POLJAKOFFF-MAYBER and S. KLEIN: Seed germination. Ann. Rev. Plant Physiol. **13**, 437—464 (1962).

TOOLE, E. H., V. K. TOOLE, H. A. BORTHWICK and S. B. HENDRICKS: Interaction of temperature and light in germination of seeds. Plant Physiol. **30**, 473—478 (1955).

— — — — Effect of temperature on germination of light sensitive seeds. Proc. Intern. Seed Testing Assoc. **22**, 1—9 (1957).

SEN, D. N.: Studies in the hydrophytes of Gorakhpur: Observations on the anatomico-physiological characters of Asteracantha longifolia NEES. — II. Proc. Nat. Acad. of Sci. B **31**, 224—234 (1961).

SEN, D. N., and U. N. CHATTERJI: Temperature relations of Ruellia tuberosa LINN. Österr. Bot. Z. **113**, 390—394 (1966).

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