Pak.J.Bot., 23(2): 249-256, 1991.

SOME AUTECOLOGICAL OBSERVATIONS ON *CATHARANTHUS ROSEUS* (L.) G.DON

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Abstract

Germination and growth of *Catharanthus roseus* seeds were found directly related to temperature. Scarification of seeds retarded germination and growth of seedlings. Germination and growth of seeds soaked in water at 30°C for 2h significantly increased in longer incubation periods. *C. roseus* was extremely sensitive to salinity. Loam soil gave maximum germination and growth. Partial sunlight and complete shade adversely affected germination and growth.

Introduction

Catharanthus roseus (syn. *Vinca rosea*) is a perennial subshrub, about 30-60 cm tall producing white and pink flowers throughout the year. It is a native of Madagascar, cultivated and naturalized in tropics and subtropics of both hemispheres (Nazimuddin & Qaiser, 1983). In Pakistan, it is commonly grown in gardens for ornamental purposes. The plant is accredited with medicinal properties and yields many alkaloids (Erdelsky & Holickova, 1978; Sharma, 1979; Chandra & Srivastava, 1980) and possesses anticancer properties (Kim, 1976). An extract from the roots is used for the cure of blood cancer (Nazimuddin & Qaiser, 1983). There does not appear to be any report on the autecology of *C. roseus*. The present study describes the effect of some environmental factors on its germination and growth.

Materials and Methods

1. ***Laboratory Experiments***: Seeds were sown on three layers of Whatman No. 1 filter paper in 9 cm diameter Petri dishes and incubated at 18, 20, 25, 30 and 35°C for 72, 144 and 192 hours. There were 10 seeds per Petri dish and each treatment was replicated 5 times.

In another set seeds were:

a. Treated with sulphuric acid for 75 seconds and washed with distilled water (Kains & McQuesten, 1960).

b. Scarified with sand paper till the testa was injured from at least one side (Pendeya *et al.*, 1968).

c. Soaked in water at 30°C for 2h (Qadir & Lodhi, 1971).

d. Tested for germination on filter paper soaked in 0.5, 1.0, 1.5 and 2.0% w/v sodium chloride in water.

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2. *Pot Experiments:* Pots with 20 cm diameter were filled with various soil types. In each pot 20 seeds of *C. roseus* were sown and germination was studied after 7, 14 and 21 days. Experiment was started in the first week of March when the conditions were ideal for the germination in open.

3. *Field and Pot Experiments*: The effect of light intensity, soil texture and concentration of sodium chloride on different parameters of the test plant were studied under field conditions from early February until first week of June. For salt tolerance the experiment was completed in early April.

a. *Light*: Seeds were sown in garden loam soil, mixed with organic matter, in 15 large-sized pots in early February. In March, the seedlings were transferred to 70X150 cm plots having same type of soil as that of the pots. After establishment, 10 plants were left at equidistance in each plot. Two seedlings were also left in each pot. The pots were divided into three equal groups each corresponding to a plot.

Plants grown in pots and plots were kept in full sunlight (FL), partial sunlight (PL) and complete shade (CS); the group in full sunlight was treated as control. Complete shade was produced by covering the plots and the pots from all sides by wooden planks and cardboard sheets. Dry branches of trees were used to produce partial light conditions in plots, whereas pots were kept under the shade of a tree. Plants were watered and hoed regularly. At the end of the experiment, the plants were watered heavily and pulled out with roots intact.

b. *Soil Texture*: In pots filled with equal volumes of 6 different soil types, 5 young seedlings were transferred in each and, after establishment, 2 were left in each pot. All pots were watered and hoed regularly. On the completion of experiment, the plants were watered heavily and pulled out with intact roots. Observations on various parameters were recorded. The experiment continued for 8 weeks and had 5 replicates.

c. *Sodium Chloride Treatment*: Two equal-sized plants were transplanted in each of 25 polyethylene bags filled with garden loam soil mixed with organic manure; the bags were kept in earthen pots with a hole in the bottom. Plants were watered daily for 4 days to ensure establishment. Pots were divided into 5 groups of 5 pots each and were treated with 0,0.5, 1.0, 1.5 and 2.0% w/v solutions of sodium chloride and distilled water. Plants received 300 ml of salt solution or distilled water daily. The plants were watered heavily and pulled out after 59 days at the completion of the experiment and the effect on various parameters was observed.

Results and Discussion

1. *Laboratory Experiments*: Germination was found to be highest in 192 h 30°C regime (Table 1) and this temperature seems to be the same when the seeds of *C. roseus* are dispersed in nature. Germination was directly proportional to the length of incubation period presumably due to an increase in imbibition capacity of the seed coat in longer incubation periods. Germination and growth showed a positive linear relationship with temperature, but beyond 30°C they no more remained temperature dependent. At higher temperatures germination occurred earlier but final percentages were lower as also reported for *Haloxylon articulatum* (Sankary *et al.*, 1972).

Table 1. Effect of time and temperature on germination and radicle length (average of 5 replications of 10 seeds each).

Temperature (C)	Incubation Hours 72		144		192	
	G (%)	R (mm)	G (%)	R (mm)	G (%)	R (mm)
18	---	---	---	---	---	---
20	---	---	10	2.8	14	3.4
25	---	---	18	3.2	20	4.4
30	10	3.4	40	6.1	56	8.4
35	04	3.3	20	4.3	40	5.9

G, germination; R, radicle length.

Detrimental effect of high temperature, alongwith some other factors, on germination and growth has been reported (Friend, 1969; Reed *et al.*, 1974; Zir *et al.*, 1973). Poor germination and growth at low temperatures and longer incubation periods were largely due to the cumulative effect of temperature.

Chemical scarification softens the testa of seeds (Kains & McQuesten, 1960) but the scarification of *C. roseus* seeds with sulphuric acid retarded the germination and growth significantly in longer incubation periods (Table 2); a similar response to sulphuric acid treatment was noticed by Qaiser & Qadir (1972). The thickness of testa alone may not be held responsible for low germination and growth; there might be some other factors such as inherent low permeability of seed coat and blockage of gaseous exchange by testa and the surrounding membrane associated with the thickness of testa (Pullock & Toole, 1961; Khanzada, 1976).

Mechanical scarification of testa generally results in increased water absorption which consequently enhances the germination (Mann *et al.*, 1981). Retarded germination and growth of *C. roseus* may be, in addition to the factors already discussed

Table 2. Effect of different treatments on the germination and radicle length (average of 5 replications of 10 seeds each).

Incubation hours	Control treatment		Sulphuric acid scarification		Mechanical treatment		Water soaking	
	G (%)	R (mm)	G (%)	R (mm)	G (%)	R (mm)	G (%)	R (mm)
72	10	3.4	9	2.4	8	2.8	40*	3.5
144	40	6.1	22*	3.9*	24*	5.3	66*	8.6*
192	56	8.4	24*	4.2*	24*	6.2	70*	8.9

* = Significant at 1% level. G, germination; R, radicle length.

Table 3. Effect of soil texture on germination in plants grown in pots.

Days	Soil Type	Germination (%)
	Clay	---
14	Sand	20
	Loam	30
	Clay	06
21	Sand	34
	Loam	52

under sulphuric acid treatment, due to the direct injury inflicted upon the young embryo as a result of mechanical scarification (Khanzada, 1976).

Seeds soaked in water at 30°C for 2 h before germination exhibited significantly high percentage of germination in all incubation periods and a relatively greater growth of radicle in 144 h of incubation (Table 2); a similar trend was noticed in *Capparis decidua* although the soaking periods were longer than used in the present study (Qaiser & Qadir, 1972). Growth inhibitory substances in seeds leach out because of soaking prior to sowing (Hemberg, 1949). In the field, the inhibitory effect is reduced as these substances, once leached out from the seeds, are removed by the soil (El-Shishing & Thoday, 1952).

C. roseus is highly sensitive to salinity of soil as no germination occurred in any concentration of sodium chloride. Inhibition may be either due to salinity interfering with the process of imbibition or the direct toxic effect of salt as reported by Francois & Goodin (1972) or both. Reduced enzyme activity due to salinity may yet be another reason of growth inhibition (Sankary *et al.*, 1972; Jones & Armstrong, 1971; Khan & Patel, 1972).

2. *Pot Experiments*: Earliest germination, i.e., in 14 days was observed in loam soil largely because of good physical characteristics of soil. The poor response in clay soils may chiefly be due to the compactness of soil which reduces the oxygen contents of soil that physically hinders the radicle growth.

3. *Field and Pot Experiments*:

a. *Light*: *C. roseus* responded to light conditions. The values of all the parameters observed were significantly reduced in partial light (PL)and complete shade (CS) in comparision with the plants grown in full sunlight (FL) both in pots and beds (Table 4). All the observed characters, except leaf length and breadth, were found directly related to the light intensity. The reverses were due to accelerated physiological reactions (Shirley, 1935). *C. roseus* therefore, seems to be a true heliophyte.

Relatively greater leaf length and breadth observed in partial light conditions are in accordance with the findings of Bensink (1960). Full sunlight reduces the size of

Table 4. Effect of light conditions after 120 days (average of 3 replications of 10 and 2 plants in each plot and pot respectively).

Condition	Light	No of branches per plant	Root length (cm)	No. of leaves per plant	Leaf length (cm)	Leaf breadth (cm)	No. of flowers per plant	No. of fruits per plant	Fresh wt. (g)	Dry wt. (g)
	FL (Control)	16	29.30	60	7.20	2.80	40.50	36.60	58.067	8.685
Plot	PL	6*	19.70*	37*	8.20	3.90	3.50*	1.20*	15.595*	1.583*
	CS	1*	13.68*	17*	5.30*	3.03	1.40*	---	3.902*	0.361*
	FL	8	28.08	58	6.70	2.70	6.30	12.80	18.39	12.642
Pot	PL	4*	18.36*	27*	7.60	3.60	2.40*	1.00*	8.489*	0.838*
	CS	1*	13.66*	20*	6.60	3.20	1.00*	---	4.580*	0.479*

* = Significant at 1% level. FL, full sunlight; PL, partial sunlight; CS, complete shade.

Table 5. Effect of soil types on various parameters after 120 days (average of 5 replications of 2 plants each).

Soil Type	Height of plants (cm)	Root length (cm)	No. of leaves/ plant	Leaf length (cm)	Leaf breadth (cm)	No. of flowers/ plant	No. of fruits/ plant	Fresh wt. (g)	Dry wt. (g)
GL	32.80	30.40	47.30	7.09	3.11	7.20	14.40	12.850	2.908
SE ±	1.23	00.81	02.09	0.91	0.23	1.08	01.31	01.82	0.21
L	23.60	32.80	27.10	5.71	2.40	5.10	1.60	6.748	0.908
SE±	00.81	02.37	01.31	0.87	0.71	0.79	0.03	0.89	0.02
C	20.70	11.90	25.80	7.47	2.06	4.00	5.20	5.587	0.808
SE ±	00.26	01.59	02.54	1.06	0.88	0.37	0.71	0.81	0.06
S	32.40	37.80	31.90	6.00	2.58	6.00	12.00	8.880	1.908
SE ±	02.03	02.08	00.85	0.37	0.27	1.12	01.23	1.03	0.31
CL	15.40	14.50	19.90	4.53	2.10	2.10	2.00	3.855	0.708
SE ±	1.21	00.89	01.81	0.82	0.71	0.74	0.64	0.36	0.04
SL	15.80	24.80	19.50	4.49	2.07	2.40	2.00	3.472	0.609
SE ±	00.97	01.52	00.75	0.61	0.69	0.25	0.73	0.47	0.05

GL, garden loam; L, loam; C, clay; S, sand; CL, clay loam; SL, sandy loam.

the cells resulting in reduced leaf size (Shirley, 1929). Feeble growth in complete shade was not only due to lack of proper light but the involvement of some other factors such as temperature, humidity, microbial activity and the position of stomatal opening controlling the gaseous exchange has also been envisaged.

b. *Soil Texture*: The best growth in garden loam soil as manifested by the enhanced values of almost all the parameters (Table 5) was largely due to organic colloids and essential nutrients present in this soil. Growth also improved in sandy soils. A number of factors which help improving the growth in sand adversely affect the growth in clay (Black, 1967).

Table 6. Effect of NaCl concentration on various parameters after 59 days expressed as percent of control.

NaCl conc. (%)	Rate of survival	Height of plants	No. of branches/	Root lenght	No. of leaves /plant	Leaf length	Leaf breadth	No. of flowers /plant/	No. of fruits plant	Fresh wt.	Dry wt.
0.5	100.0	91.7	37.5*	76.0*	88.7	91.2	96.1	15.0*	3.1*	89.9	97.2
1.0	80.0	67.4*	12.5*	76.0*	58.8*	82.4	80.7	—	—	50.9*	49.5*
1.5	70.0*	51.0*	—	49.2*	42.2*	70.1*	61.5*	—	—	30.0*	41.9*
2.0	60.0*	36.7*	—	37.4*	35.4*	64.9*	61.5*	—	—	26.7*	27.6*

Eachvalue is the mean of 5 replicates with 2 plants each. * = significant at 1% level.

c. *Sodium Chloride Treatment*: Plants survived in 0.5% solution of sodium chloride but all the observed characters were adversely affected. With increasing concentration, the growth was stunted and death of many plants ensued. Salinity exerts biochemical and physiological stresses on the growth of plants consequently reducing the photosynthetic activity of the plant (Lapina & Popu, 1970). The values of all the parameters were found to be very low (Table 6). A singificant negative correlation was observed between salinity and the observed characters and it is in conformity with the earlier findings (Niazi *et al.*, 1985).

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(Received for Publication 27 January 1990)