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Effect of temperature and salinity on the seed germination and seedling emergence of *Trichosanthes cucumerina*

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Abstract

This study was conducted to examine the effects of temperature and salinity on the seed germination and early seedling emergence of *Trichosanthes cucumerina* (snake guard). Each set of triplicate petridishes were filled with sterile cotton wool moist with water and snake gourd seeds were placed and allowed to germinate at different temperatures in dark growing conditions for seven days. Similar process was repeated with different concentration of sodium chloride solution and allowed to germinate at 35^{o}C. Parameters measured were the percentage of germination, germination index, mean time to germination and the length of germ tube. The optimum germination characteristics were observed at 35^{o}C temperature and 50mM NaCl concentration under moderate moisture condition.

Keywords: *Trichosanthes cucumerina*, germination index, NaCl, temperature, length of germ tube.

Introduction

Trichosanth escucumerina (Snake gourd) is a monoecious annual vine growing in a subtropical or tropical vein. In Asia, people usually eat immature fruit of snake gourd as vegetable. Mature fruit pulp is too bitter, and it is used as an economical substitute of tomato. Snake gourd seeds are well adapted to the adverse environmental conditions. During the period of storage the seed content undergo different biochemical reactions and cause seed damage (Kausar, 2009).

Seed germination is a critical stage of every plant life. In germination period temperature and salinity tolerance are important for the establishment of plants that are grown in saline soils. Different components require at different rates for seed germination (Rizzardi, 2009). Germination of seeds depends on both internal and external factors of seeds. For the successful seed germination, diverse environmental factors should be provided at the optimum level. Salinity could be meant as the accumulation of salt in soil and water. Soil structure, infra-structure, water quality, plant growth and yield can be adversely affected by higher level of NaCl concentration (Scott, 1984). When the salinity level increases beyond a certain level then it can cause a significant reduction in the germination percentage, rate of germination, individual length of shoot and roots and fresh weights of the root (Hegarty, 1978). In tropical regions of the world, the crop production can be particularly affected by the soil salt concentration (Ahmed, 2009). In some halophytic grasses, germination may be possible under non saline conditions (Gulzar, 2002). Some seeds show optimum rate of germination in cool temperatures but some other seeds show optimum germination in between warm and cool temperatures. Distributions of territory plants and seed germination are mainly affected by the temperature (Guan, 2009). To break the dormancy different seeds require various temperatures. Cellular metabolism of the germinating seeds mainly depends on the amount of water uptake by seeds.

Snake gourd is cultivated in a wide range of climatic and geographic locations of the Island of Sri Lanka as a vegetable. Since there have been no published information available comparing the differences in germination potential /index and seedling growth rates of snake gourd growing in different saline and temperature zones of Sri Lanka. Therefore, it was decided to study the effects of temperature and salinity on the seed germination and early seedling growth of *Trichosanthes cucumerina*.

Materials and Methods

Source of seeds

The *Trichosanthes cucumerina* (snake gourd) seeds were obtained from Agricultural farm school of Northern Province, Thirunelvely, Sri Lanka.

Effect of temperature

A set of three sterile petridishes were taken and they were filled with sterile cotton wool moist with sterile water. In each petridish, ten seeds of *Trichosanthaes cucumerina* were placed separately. After moisten by 20ml of sterile water, the petridish was kept in a water bath set at 20°C, under dark warm condition that is favourable for natural seed germination, for 7 days. The same experiment was repeated with 25, 30, 35 and 40°C temperatures. To avoid the seeds getting dried, the cotton wools were moisten by 5ml of sterile distilled water every day. The seeds were carefully observed daily and the percentage of germination, germination index, general normal seedling percentage and mean time to germination and the length of germ tube were measured. At the end of the germination period, all the values were calculated.

Effect of Salinity

A set of three sterile petridishes were taken and they were filled with sterile moist cotton wool. In each petridish, ten seeds of *Trichosanthes cucumerina* were placed separately. Then the petridishes were moisten by 40ml of 50mM sodium chloride solution. All petridishes were placed in water baths set at 35°C and left in dark for 7 days for natural seed germination. The same experiment was repeated with 100,150, 200, 250 and 300mM concentration of sodium chloride solutions. The seeds were carefully observed daily and all the same parameters were recorded as for the temperature experiment.

Statistical analysis

Statistical analyses were performed using R 2.15.3 statistical software at $\alpha = 0.05$ confidence level. The data sets were checked for the parametric assumptions of normality and homogeneity of variances. The data were analyzed using ANOVA followed by Tukey's multiple comparison test to determine significant differences at $p \leq 0.05$ (R Development Core Team, 2011).

Results and Discussion

Trichosanthes cucumerina has the capacity of growing in a wide range of temperatures. After five days of germination period, the germination percentage was very low at 20°C (Figure 1). Germination percentage was increased with the temperature up to 35°C and beyond this temperature germination percentage started to decline. The length of germ tube also showed similar trend as the germination percentage (Figure 2). The germ tube length was significantly lower at 20°C than that of 35°C.

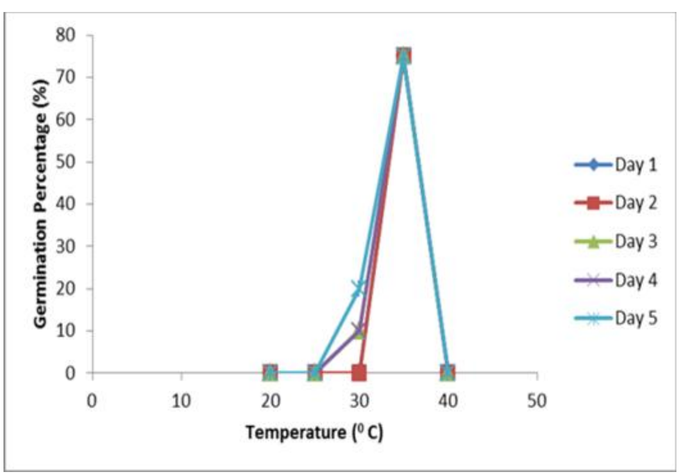

Figure 1: Percentage of germination of *Trichosanthes cucumerina* seeds at different temperatures.

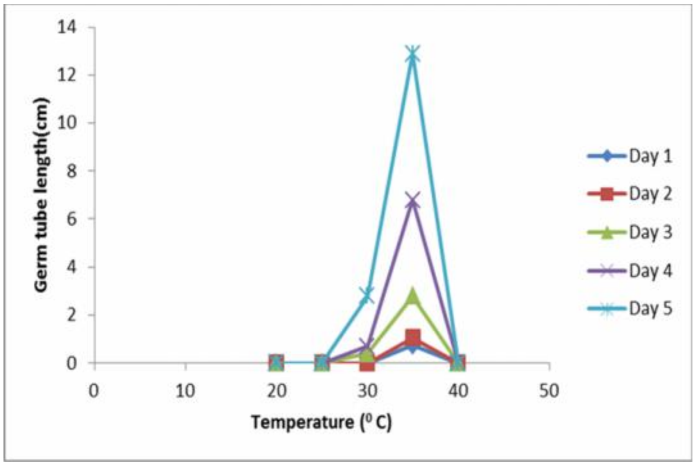

Figure 2: Length of germ tube of the seedlings of *Trichosanthes cucumerina* at different temperatures

After seven days of germination of seeds of *Trichosanthes cucumerina*, the germination mean time (GMT) was found to be higher at 35^{o}C. GMT obtained at 35^{o}C was significantly higher than the other temperatures. When the temperature was increased to 40^{o}C, the GMT declined (Figure 3). Under various temperature treatments seeds of snake gourd showed diversity in responses. The Germination index of the seeds of snake gourd expressed similar trend as germination mean time (Figure 4).

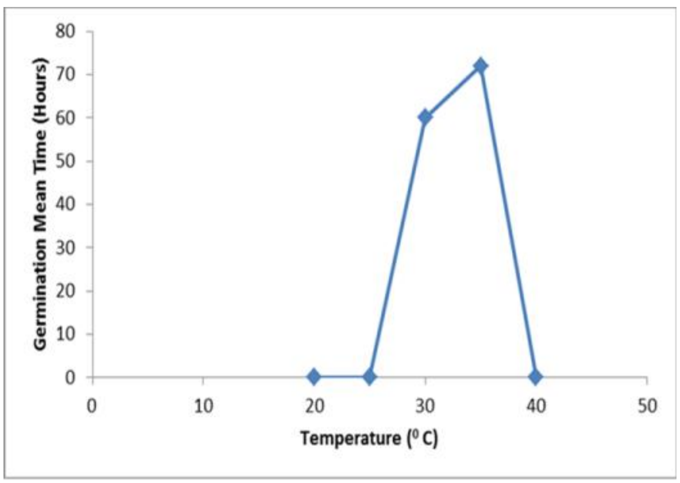

Figure 3: Mean time of germination of *Trichosanthes cucumerina* seeds at different temperatures.

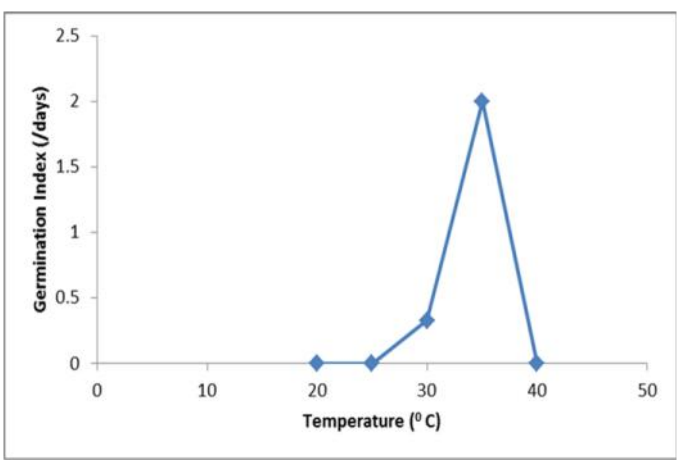

Figure 4: Germination index of *Trichosanthes cucumerina* seeds at different temperatures.

Figure 5: Seeds of *Trichosanthes cucumerina* showing difference responses at different temperatures after 5 days. A - 20^{o}C, B- 25^{o}C, C- 30^{o}C, D- 35^{o}C and E - 40^{o}C.

At lower temperatures, pores of aquaporins will be kept closed and the water conductivity will be highly reduced. When the temperature is high, the rate of evapo-transpiration from plants will be higher and this might inhibit seed germination. Root water flux decreases with decreasing temperature (Chung, 2012). The maximum percentage of seed germination was obtained at 35^{o}C temperature for the snake gourd. This temperature is said as the optimum temperature for all the individuals of snake gourd. As the temperature declines or advances from 35^{o}C, two events might happen at the same time. When the percentage of germinating seeds decreases, the number of days taken to germinate would increase. That is the basic relationship between the seed germination and the increase in temperature. For every species, there is an optimal soil temperature for seed germination, and maximum number of seeds will germinate at this temperature in lesser time than any other temperature (Thananthika et al 2015). The enzymes that involved in germination might be more active at the optimum temperature (Ellis, 1994).

After five days of seed germination, the germination percentage of snake gourd seeds at 50mM of NaCl was significantly higher than that of other NaCl concentrations (100, 150, 200 and 250mM). The germination percentage of snake gourd was inhibited at very high salinity concentrations. Beyond 200mM of NaCl concentration, germination was completely inhibited (Figure 6). Very high NaCl concentrations inhibit the seed germination of snake gourd. The variation in the germ tube length also showed similar trend as the germination percentage (Figure 7). It could be concluded that the snake gourd has a very limited tolerance to salinity and cannot grow in a wide range of salinity variations.

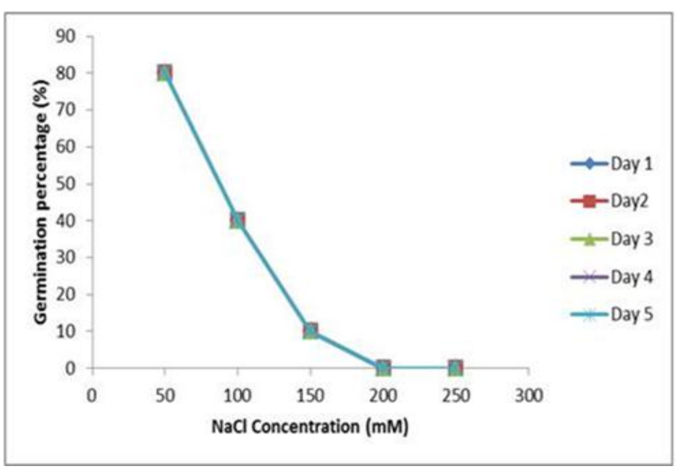

Figure 6: Percentage of germination of *Trichosanthes cucumerina* at different NaCl concentrations.

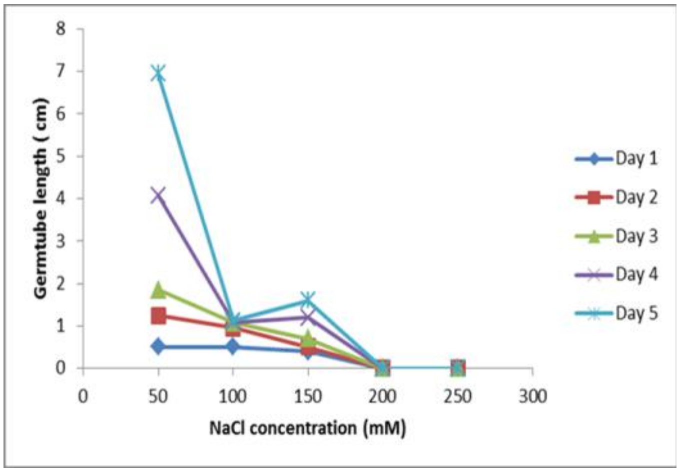

Figure 7: Length of germ tube of *Trichosanthes cucumerina* at different NaCl concentrations.

After seven days of germination of *Trichosanthes cucumerina*, germination Mean Time was stable at lower concentrations of NaCl (50mM, 100mM and 150mM). Beyond 150mM of NaCl, the germination mean time (GMT) of *Trichosanthes cucumerina* was significantly lower than all the other tested NaCl concentrations. When the NaCl concentration was further increased to 200mM, the GMT declined and no germination was reported (Figure 8). Germination index of *Trichosanthes cucumerina* showed similar trend as the germ tube length (Figure 9). Under different salinity treatments *Trichosanthes cucumerina* seeds showed various germination responses.

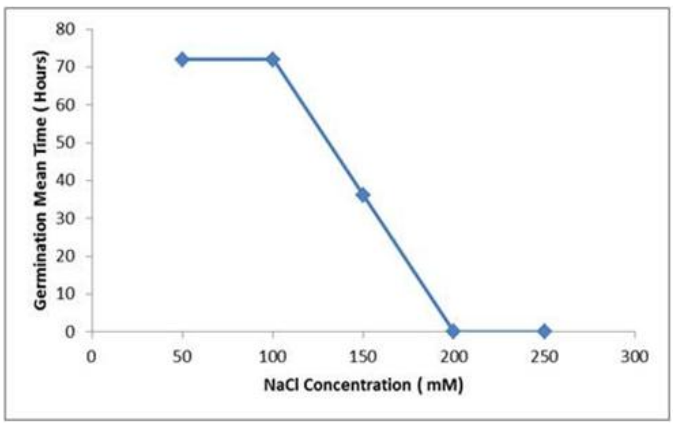

Figure 8: Germination Mean Time of *Trichosanthes cucumerina* at different NaCl concentrations.

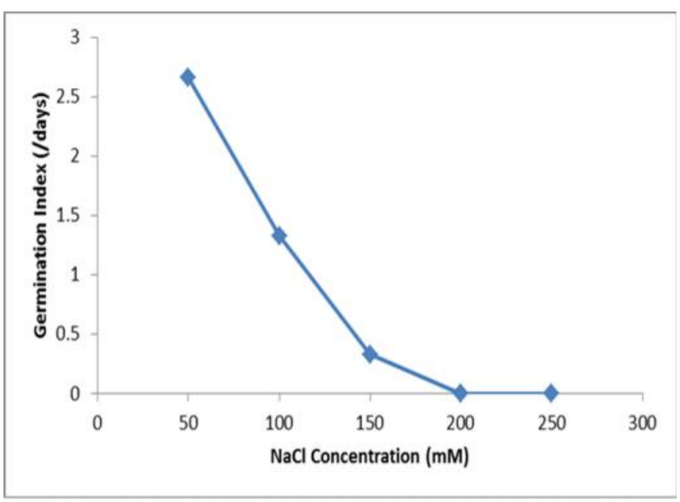

Figure 9: Germination Index of *Trichosanthes cucumerina* at different NaCl concentrations.

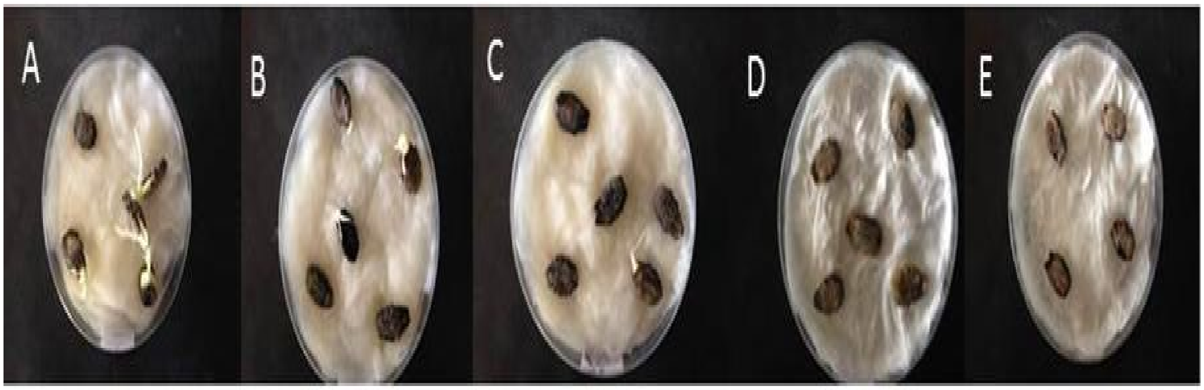

Figure 10: Seeds of *Trichosanthes cucumerina* showing difference responses at different NaCl concentrations after 5 days. A-50, B-100, C-150, D-200 and E-250 mM NaCl concentration.

Increased sodium chloride concentration levels caused a significant reduction in the seed germination and seedling growth rate in *Trichosanthes cucumerina* under the conditions tested. Effect of salt would cause physiological drought in seed and plant growth. Salt reduces the water potential of the substrate solution, which inhibits plant water supply. In salty media, plants receive higher amount of salt in root cells that leads to water potential reduction. Therefore there will be a raise in the water absorption under physiological drought condition to a certain extent (Gutterman, 1993). There are detrimental effects of NaCl may be linked to long-term effects of accumulated toxic ions. Na+ will inhibit most of the enzymes at a concentration above 100mM. The concentration at which Cl– becomes toxic beyond certain level and this is not well defined, but is probably in the same range as that for Na+ (Munns, 2006). The activity of most enzymes inside the seeds and seedlings is negatively affected by high salt concentrations due to perturbation of the hydrophobic–electrostatic balance between the forces maintaining protein structure. However, toxic effects on plant tissues occur even at moderate salt concentrations of about 100mM, unveiling specific salt toxicity targets (Serrano, 2001). Apoplastic enzymes from most of the halophytes have been shown in vitro to be salt insensitive, coping with NaCl concentrations up to 500mM (Thiyagarajah, 1996). Halophytes vary in their ability to adaptation to tolerate salt (Khan, 1997).

The percentage of germination is decreasing, might be due to the enzymatic reactions that take place under the treatment conditions of seeds (Geressu and Gezahagne, 2008). In natural habits temperature and salinity plays an important role in seed germination and early seedling emergence. (Ungar, 1977).

Conclusion

Salinity and temperature affect the seed germination and seedling emergence of *Trichosanthes cucumerina*. Optimum germination responses were expressed by *Trichosanthaes cucumerina* at 35^{o}C temperature and100mM NaCl concentration under normal growing conditions.

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