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Effect of HCl pretreatment on tomato (*Solanum lycopersicum* L.) seed germination.

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Abstract:- The practical utility of seed pre-treatment is well documented. Seed pre-treatment has been utilized to improve the germination of different crop species. In the present study, the effect of pre-treatment of Tomato (*Solanum lycopersicum* L.) seeds, which is one of the important vegetable crops with hydrochloric acid (HCl) was analysed. Tomato seeds were soaked in distilled water and two concentrations of HCl (0.03 N and 0.3 N) for three different time periods i.e., 2 hours, 4 hours and 6 hours. After the pre-treatment, seeds were sterilized using 5% of sodium hypochlorite (NaOCl) for 5 minutes. Treated seeds were placed on the sterilized petri dishes lined with moistened Whatmann 1 covered with lid. Germinated seeds were counted every 24 h for 10 days. Data was used to calculate percentage germination, mean time of germination and the rate of germination. Results indicated that percentage germination was improved significantly when tomato seeds were soaked in 0.03 N concentration for 2, 4 and 6 hours. Rate of germination improved with 0.03 N treatment of HCl for a duration of 6 hours. Therefore, an optimum concentration of HCl for a particular amount of time may have stimulatory effect on the germination of tomato seeds and can improve the yield.

Keywords:- *Tomato, Seed Germination, Pretreatment, HCL*

I. INTRODUCTION

Seed germination is a vital process which can influence the yield and production of crop plants. It is a complex phenomenon that involves many physiological and biochemical changes that contribute to activation of embryo pertinent for seed germination [1,2]. The inability of a viable seed to germinate, even under ideal growing conditions is referred to as seed dormancy. Dormancy enables seeds to cope up under external environment when seed is separated from mother plant and required to be dispersed before reaching the favourable conditions for germination. External conditions including light, temperature, and duration of seed dry storage, along with genetic factors, influence it. Dormancy is used by plants so that seeds can withstand adverse conditions and not all sprout simultaneously and get killed by bad weather, ensuring the survival of a species [3,4]. Although dormancy might aid plants in surviving in the wild, it can also hinder the uniform germination and healthy growth of seeds in fields [4]. Seed dormancy can be broken by a number of methods such as soaking seeds in water or in different solutions such as inorganic salts solution or in organic solutions at different temperatures [5]. Dormancy can be physical, physiological, chemical or mechanical and is classified into two types: primary and secondary dormancy [6,7]. Primary dormancy is the phenomenon in which a seed becomes dormant during its development. This type of seed does not germinate when exposed to water. Primary dormancy can be broken by chemical scarification (using acid treatment). After overcoming primary dormancy, if seeds are exposed to suitable conditions (for example, optimum temperature, water, and light), germination can be achieved. If these requirements are not satisfied, seeds may begin a fresh dormant stage known as secondary dormancy. Chemical scarification can also help to break secondary dormancy [8,9,10]. Seed germination is the primary phase that assures the formation of seedlings and, eventually, agricultural production, so overcoming seed dormancy is critical for crop yields.

Tomato is a warm season crop that requires relatively long seasons and is adapted to a variety of climatic as well as soil conditions [11]. Despite being the third-largest vegetable harvest in the world after potatoes and sweet potatoes, tomatoes are the most popular canned vegetable. Because of its high nutritive value, tomatoes are considered one of the most important "protective foods.". It is one of the most versatile vegetables, with a wide range of applications in Indian cuisine. Since, tomato has gained popularity among other vegetables and the delay in its germination can hamper the production. Both primary and secondary dormancy is present in tomato seeds [12]. Dormancy must be broken in all the seeds of a cultivated plants so as to achieve uniform germination rate. Much research on breaking the seed dormancy of tomato using HCl has not been carried out till date.

Therefore, in the present study, the effect of soaking of tomato seeds in hydrochloric acid and distilled water on the germination was studied. This would help us to know if such pre-treatment methods can help in improving germination of tomato.

II. MATERIALS AND METHODS

In order to study the effect of HCl and distilled water on the germination of *Solanum lycopersicum* L. seeds, these were soaked in distilled water 0.3 N concentrated hydrochloric acid (HCl) and 0.03 N diluted hydrochloric acid. The soaking treatment was carried out for the durations of 2, 4 and 6 hours. After soaking treatment, seeds were washed thoroughly with distilled water. Subsequently, seeds were airdried and surface sterilized by dipping in 2% sodium hypochlorite (NaOCl) for five minutes. Seeds were then thoroughly rinsed with sterilized distilled water and placed in sterilized petri-plates lined with moistened. The experiment had five replicates and each replicate had 20 seeds. Petri dishes were then transferred to the seed germinator (Sunpharma, themotech rpm - 101) with alternate light period of 7 hours followed by dark period of 17 hours. The constant temperature (25°C) and relative humidity (40 - 50%) was maintained. The Petri dishes were placed randomly. Observations on seed germination were recorded after every 24 h for 12 days. Germination was considered when the tip of the healthy, white radicle had grown free of seed coat. Seeds soaked in distilled water served as control.

➢ *Calculation*

After noting the number of seeds germinated each day for 10 days, percentage germination, rate of germination, mean time germination was calculated by using following formulae:

- *Germination Percentage:*

GP=(n/N) ×100

Where n and N corresponds to number of seeds germinated and total number of seeds respectively.

- *Mean germination time*

MGT= ni ti/ ni

Where ni is the number of seeds germinated per day (not the accumulated number, but the number corresponding to the *i-th* observation), and *ti* is the time since the beginning of the germination test up to the *i-th* observation. [13].

- *Rate of germination:*

RG= N/MGT

where, RG = Rate of germination per day; N = total number of seeds germinated in the treatment; MGT = Mean germination time [13].

T10

Time (in days) required to reach 10% of final germination percentage

The data thus obtained for percentage germination, rate of germination and mean time germination and T10 was analysed statistically for two-way ANOVA to study the interaction of two factors i.e. time of soaking and concentration of HCl. Statistical analysis was done using SPSS, version 2020.

III. RESULT AND DISCUSSION

Results indicated that the HCl significantly influenced the percentage of germination ($F=3.276$, $P<0.05$) and rate of germination ($F=8.168$, $P<0.05$). The interaction between time of soaking and concentration of HCl is found to be significant for percentage germination ($F=5.578$, $P=0.001$) and rate of germination ($F=4.538$, $P=0.005$). The mean for all the parameters are presented in table 1. The percentage germination of the seeds soaked for 4 hours and 6 hours in lower concentration i.e. 0.03 N HCl is more compared to when soaked in distilled water for the same amount of time (Fig. 1). The similar trend is observed for rate of germination (Fig. 2). Thus, both rate of germination and percentage germination are high when seeds were pre-treated with 0.03 N HCl (Fig. 1,2 and Table 1). This could be because of the ability of dilute HCl to overcome the dormancy in tomato plant [3,14]. Bussel and Gray (1976) used pre-sowing seed treatments in tomato to improve seed germination and emergence [15]. HCl-treatment is used in order to peel the seed coat [16]. According to (Nikoleave, 1977) acid causes the seed coat to dissolve and exposes the macroscleids cells' lumen, allowing for water intake, which ultimately aids germination [17]. Also, acid treatment allows the release of simple sugars that can be readily employed in the synthesis of protein, the secretion of hormones like auxin and ethylene further increases nucleic acid metabolism and in turn accelerate germination [18]. Soaking the seeds for a longer duration in 0.3 N HCl inhibited the seed germination. This may be because of the corrosive effect of higher concentration of HCl on seed embryo [19]. HCl is a strong acid and prolonged exposure to it can harm crucial proteins needed for germination. The higher concentration of HCl i.e. 0.3 N is found to be inhibitory whether seeds were soaked for 4 hours or 6 hours. HCl treatment has also been shown to improve germination in sugar beet seeds [20,21]

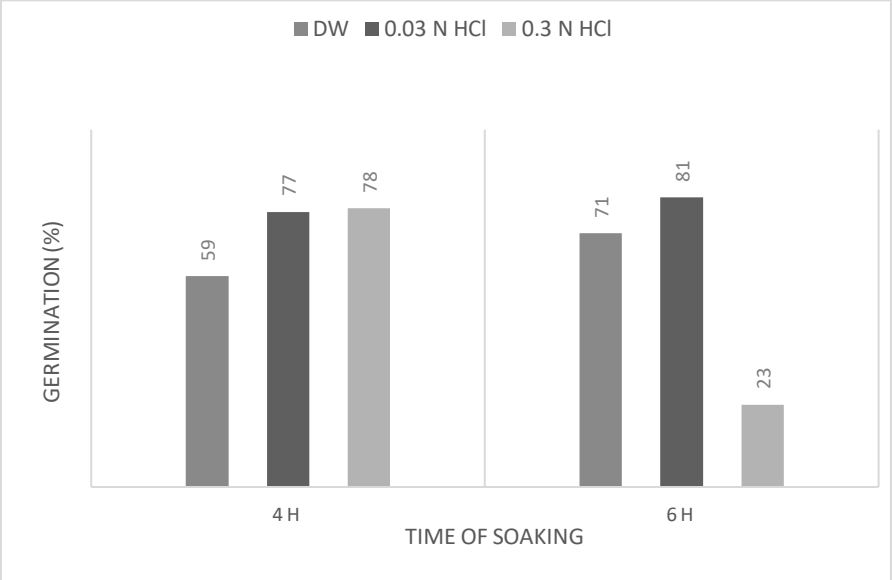

Fig 1. Effect of HCl concentration on percentage germination and rate of germination

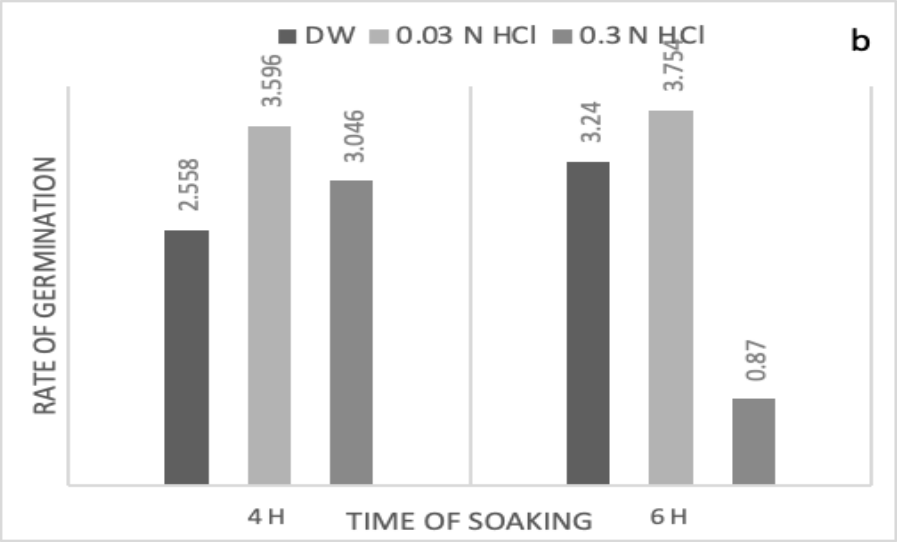

Fig 2. Effect of HCl concentration on percentage germination when seeds were soaked for 4 hours and 6 hours

Table 1. Effect of two concentrations of HCl on percentage germination (PG), Rate of germination (RG), Mean time germination (MTG) and time taken to achieve 10 percent of total germination (T10).

	Time of soaking = 2h		**Time of soaking = 4h**		**Time of soaking = 6h**	
Parameter	**HCl Conc. (N)**	**Mean**	**HCl Conc. (N)**	**Mean**	**HCl Conc. (N)**	**Mean**
PG	0 0.03 0.3	78 71 74	0 0.03 0.3	59 77 78	0 0.03 0.3	71 81 23
RG	0 0.03 0.3	3.654 3.422 2.96	0 0.03 0.3	2.558 3.596 3.046	0 0.03 0.3	3.24 3.754 .87
MTG	0 0.03 0.3	4.38 4.18 5.032	0 0.03 0.3	4.64 4.42 5.48	0 0.03 0.3	4.462 4.376 3.69
T10	0 0.03 0.3	3.00 3.20 3.40	0 0.03 0.3	3.0 3.2 3.4	0 0.03 0.3	3.0 3.4 2.8

IV. CONCLUSION

This is a preliminary work which indicates that soaking of tomato seeds for a certain period of time in HCl may have a potential to increase the germination of the tomato, which as a consequence would help in improving the yield of the tomato. Further studies should be carried out to substantiate the process of seed germination in the field. Also, the cost effectiveness of the use of HCl as a pre-treatment for increasing the yield should be examined at commercial level.

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Declaration

This manuscript is an outcome of undergraduate students' experimental work. The manuscript has been prepared through contributions of all authors. All authors have given approval to the final version of the manuscript. All authors declare that they have no conflicts of interest.

REFERENCES

[1]. Hao F, Boris N, Jonathan W. D., "Molecular mechanisms of seed germination," in Sprouted Grains, AACC International Press 2019 pp 1-24 DOI:https://doi.org/10.1016/B978-0-12-811525-1.00001-4.

[2]. Lincoln T, Eduardo T, "Abscisic Acid: A Seed Maturation and Stress-Response Hormone," in Plant Physiology. 5th Edition, Sinauer Associates, Inc., Sunderland, 2010, pp 673-698

[3]. Abubakar Z., Maimuna, A., "Effect of Hydrochloric Acid, Mechanical Scarification, Wet Heat Treatment on Germination of Seed of Parkia Biglobosa African Locust Bean (Daurawa) Case Study of Gombe Local Government" Area. Journal of Applied Sciences. Vol. 17. pp 119-123. 2013

[4]. L. Bentsink, M. Koornneef, "Seed dormancy and germination," in The Arabidopsis book, vol. 2008, no. 6, pp 1-18, 2008. DOI: https://doi.org/10.1199/tab.0119

[5]. M. Ashraf , M. R. Foolad. "Pre-sowing seed treatment: A shot gun approach to improve germination, plant growth and crop yield under saline and non-saline conditions," Advances in Agronomy vol. 88 pp 223-271, 2005. DOI: https://doi.org/10.1016/S0065-2113(05)88006-X

[6]. C. C. Baskin, J.M. Baskin, "Types of Seed Dormancy" in Seeds, Academic Press. San Diego, CA pp 27-47, 1998 DOI: https://doi.org/10.1016/B978-012080260-9/50003-8.

[7]. J. M. Baskin, C. C. Baskin, "A classification system for seed dormancy". Seed Science Research vol. 14, no. 1 pp 1-16. 2004. DOI: https://doi.org/10.1079/SSR2003150

[8]. S. S. Parihar, M. Dadlani, D. Mukhopadhyay, S. K. Lal, "Seed dormancy, germination and seed storage in henna (*Lawsonia inermis*)." The Indian Journal of Agricultural Sciences, vol. 86, no. 9 pp 1201-1207, 2016

[9]. J. D. Bewley, "Seed Germination and Dormancy," The Plant Cell, Vol. 9, no. 7, pp 1055–1066, 1997 DOI: https://doi.org/10.1105/tpc.9.7.1055

[10]. A. L. Torres-Gonzalez, "Seed dormancy and germination in tree tomato (*Solanum betaceum* Cav.) and lulo (*Solanum quitoense* Lam.)," Revista Colombiana de Ciencias Hortícolas. Vol.13 no. 3 pp 336-47, 2019

[11]. R. E. Vincent, M. Yamaguchi, "Environmental Factors influencing the Growth of Vegetables," in World vegetables. Springer New York, NY, pp 59-80, 1997. DOI: https://doi.org/10.1007/978-1-4615-6015-9

[12]. N. Sudhakar, D. Nagendra-Prasad, N Mohan, B. Hill, M. Gunasekaran, K. Murugesan, "Assessing influence of ozone in tomato seed dormancy alleviation," American Journal of Plant Sciences vol. 2, no. 3, pp 443-448, 2011. DOI: http://dx.doi.org/10.4236/ajps.2011.23051

[13]. M. A. Ranal, D. G. D., "How and why to measure the germination process?," Brazilian Journal of Botany, Vol. 29, no. 1 pp 1-11, 2006. DOI:https://doi.org/10.1590/S0100-84042006000100002

[14]. R. Q. Miranda, M. T. Oliveira, R. M. Correia, J. S. Almeida-Cortez, M. F. Pompelli, "Germination of Prosopis juliflora (Sw) DC seeds after scarification treatments," Plant Species Biology. vol. 26, pp 186-192, 2011. DOI: https://doi.org/10.1111/j.1442-1984.2011.00324.x

[15]. W.T. Bussell, D. Gray, "Effects of pre-sowing seed treatments and temperatures on tomato seed germination and seedling emergence," Scientia Horticulturae, Vol. 5, no. 2, pp 101-109,1976.DOI:https://doi.org/10.1016/0304-4238(76)90072-8.

[16]. J. Levitt, "Introduction to plant physiology," Mosby, 2nd edition, 1974, pp 1-447.

[17]. M. G. Nikoleave "Factors Controlling Seed Dormancy Pattern," North Holland Publishing Co. Amsterdam, 1977, pp. 51-74

[18]. P. T. Irwin, "Plant Physiology'" Addison-Wesley Pub. Co. Inc. U.S A, 1982, pp. 501-540

[19]. A. Younis, A. Riaz, R. Ahmed, A. Raza, "Effect of hot water, sulphuric acid and nitric acid on the germination of rose seeds," Acta Horticulturae, vol. 755. pp 105-108, 2007. DOI:10.17660/ActaHortic.2007.755.12.

[20]. M. J. Durrant, S. J. Mash, P. A. Payne, "The use of hydrochloric acid to improve the germination of sugar-beet seed," Plant Growth Regul vol. 11, pp 363–369, 1992. DOI:https://doi.org/10.1007/BF00130643

[21]. M. Habib, "Sugarbeet (Beta vulgaris L.) seed pre-treatment with water and HCl to improve germination," African Journal of Biotechnology, vol. 9, no. 9, pp 1338-1342, 2010. DOI: https://doi.org/10.5897/AJB10.1460