

*Full Length Research Paper*

# Effects of soaking duration on germination and seedling growth of tomato (*Lycopersicum esculentum* Mill)

S. Sabongari\* and B. L. Aliero

Department of Biological Sciences Usmanu Danfodiyo University, Sokoto

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The effects of soaking duration on germination and seedling growth of tomato (*Lycopersicum esculentum* Mill) Roma VF, UC82B and Xina varieties were investigated. The treatments consisted of three soaking durations (12, 24, 36 h) and control replicated four times in a latin square design. Results indicated significant enhancement of germination by all soaking durations except for Xina variety where 36 h treatment showed no significant difference from the control. Maximum total germination (%) was obtained under 24 h treatment for all the seed varieties. Soaking durations of 12 and 24 h enhanced growth and dry matter accumulation for both Roma VF and UC82 B. The study has demonstrated the advantages of soaking seeds in water for about 24 h prior to sowing them in the field.

**Key words:** Seed, tomato, soaking duration, varieties, germination, seedling, growth.

## INTRODUCTION

*Lycopersicum esculentum* Mill (Solanaceae) is one of the world's most important vegetable crops with a current worldwide fresh weight production of 80 million metric tones from a cropped area of approximately three million hectares (Johannes et. al., 2000, Anonymous, 1993). The fruit improves the supply of vitamins and minerals in human nutrition (Bako, 1990). In Nigeria it is a good source of income for many farmers in both local and export trade.

Tomato could be propagated vegetatively by stem cuttings, tissues culture, grafting or sowing of seeds in the field. However, because of the prevalence of virus diseases which would be transmitted by vegetative propagation, seed is the safest and most reliable way of propagation (Yamaguchi, 1983).

The key to success in seed propagation is proper timing of germination. Where the period of germination is prolonged, the emerging seedling is exposed to risk of attack by soil microbes or lack of sufficient moisture, light or oxygen. The idea of soaking seeds before sowing is aimed at shortening the lag phase in germination and to enhance seedling establishment thereby minimizing the risk in the early vegetative growth. It is the object of this study is to identify the most effective soaking period for germination, growth and development of tomato seedlings.

## MATERIALS AND METHODS

Three varieties of tomato (*Lycopersicum esculentum* Mill) namely var. Roma VF, UC82B and Xina were used for the study. The seeds were obtained from Zamfara State farmers Agricultural Supply Company (FASCO) Gusau and the experiment carried out under green house condition at College of Agriculture, Zuru, Kebbi State,

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\*Corresponding author. E-mail: blaliero@yahoo.co.uk.

**Table 1.** Water intake (%  $\pm$ S.E.) of seeds ROMA VF, UC82B and XINA tomato varieties.

Variety	Soaking duration (h)		
	12	24	36
ROMA VF	79.00 $\pm$ 0.39	81.90 $\pm$ 0.41	94.00 $\pm$ 0.47
UC82B	75.20 $\pm$ 0.37	89.10 $\pm$ 0.44	90.00 $\pm$ 0.45
XINA	93.40 $\pm$ 0.46	98.60 $\pm$ 0.49	100.00 $\pm$ 0.50

Values: mean of 4 replicates.

**Table 2.** Germination (%) of ROMA VF seeds during fourteen days of sowing.

Days after sowing	Soaking duration (h) and No. of seeds sown			
	0	12	24	36
0	-	-	-	-
1	-	-	-	-
2	-	-	-	-
3	-	-	45.25 $\pm$ 1.4	38.75 $\pm$ 1.0
4	-	34.00 $\pm$ 1.6	37.25 $\pm$ 1.3	35.75 $\pm$ 1.3
5	11.50 $\pm$ 0.5	30.25 $\pm$ 1.8	16.00 $\pm$ 0.4	14.25 $\pm$ 0.6
6	18.50 $\pm$ 1.1	12.50 $\pm$ 0.4	4.50 $\pm$ 0.4	4.75 $\pm$ 0.4
7	17.00 $\pm$ 1.0	8.75 $\pm$ 0.3	-	-
8	11.75 $\pm$ 0.8	2.75 $\pm$ 0.3	-	-
9	7.50 $\pm$ 0.5	-	-	-
10	3.75 $\pm$ 0.5	-	-	-
11	3.50 $\pm$ 0.3	-	-	-
12	-	-	-	-
13	-	-	-	-
14	-	-	-	-
<b>Total</b>	70.00 $\pm$ 1.5	88.25 $\pm$ 0.8	98.00 $\pm$ 0.9	93.50 $\pm$ 1.1

Values: mean of 4 replicates.

Nigeria. Viability test was carried out in the laboratory as described by Evans (1992) and John and Paul (1993). The seeds were then further treated to determine their moisture content and amount of water intake during the soaking period. Moisture content was determined by weighing 100 seeds of each variety of tomato to obtain the initial weight. They were then dried at interval of 30 min in an oven at 70°C until constant weight was obtained. To determine the amount of water imbibed by each variety, 100 seeds were also weighed initially, then soaked in water for 12, 24 and 36 h duration. At the end of each period, the seeds were reweighed accordingly to obtain their weight after soaking.

Soaking of seeds for germination was done by complete immersion of 100 seeds of each variety in each of 12 replicate petridishes (9 cm) per treatment. After soaking the seeds were immediately transferred into growth bags containing wet sterilized (in 40% formalin) soil and sown at 0.5 cm apart (Onwueme, 1974). The bags were of 35 cm by 25 cm with and 33 cm depth dimension. They were replicated into four for each treatment and arranged in a latin square design (Gomez and Gomez, 1984). Moisture was supplemented by addition of 1 L of water in each bag every morning for 14 days. Emergence of the radical from the soil was regarded as successful germination. The percentage of the sown seeds emerging to the surface were calculated daily and recorded for two weeks. Seedling growth (10 representative) was measured by shoot height, number of leaves, stem diameter and dry matter

production for each parameter. All data obtained were subjected to statistical analysis means and standard error determined.

## RESULTS

Seeds viability was very high as indicated by these percentages: 91 $\pm$ 1.87 for UC82B, and 95 $\pm$ 1.87 for Roma VF and Xina. Mean percentage moisture content was 4.7 $\pm$ 0.09 for UC82B, 5.1 $\pm$  0.10 for Roma VF, and 10.2 $\pm$ 0.20 for Xina. The amount of water imbibed increases steadily with increase in time of soaking for all the varieties (Table 1). In Roma VF, it ranged between 79 and 94%, 75 to 90% for UC82B, and in Xina, 93 to 100%.

Soaking of seeds promoted germination by high percentage emergence at shorter period in all the seeds of the tomato varieties and for all treatments. Soaked seeds of Roma VF (Table 2) started to germinate two days earlier than the control when soaked for 24 and 36 h. Soaking for 12 h promoted germination a day earlier than the control. All treated seeds of this variety had

**Table 3.** Germination (%) of UC82B seeds during fourteen days of sowing.

Days after sowing	Soaking duration (h) and No. of seeds sown			
	0	12	24	36
0	-	-	-	-
1	-	-	-	-
2	-	-	-	-
3	-	-	-	-
4	-	-	-	-
5	-	5.75±0.5	48.75±1.4	57.75±2.3
6	3.25±0.4	44.35±2.1	40.50±2.0	33.75±2.0
7	39.25±1.8	22.25±0.9	9.25±0.4	4.75±0.8
8	14.75±0.9	14.75±1.	-	-
9	6.75±0.4	2.50±0.2	-	-
10	3.75±0.5	-	-	-
11	3.50±0.3	-	-	-
12	-	-	-	-
13	-	-	-	-
14	-	-	-	-
<b>Total</b>	71.25±1.5	71.25±1.5	98.50±0.60	96.25±0.5

Values: mean of 4 replicates.

**Table 4.** Germination (%) of Xina seeds during fourteen days of sowing.

Days after sowing	Soaking duration (h) and No. of seeds sown			
	0	12	24	36
0	-	-	-	-
1	-	-	-	-
2	-	-	-	-
3	-	-	-	-
4	-	5.75±0.3	4.50±0.5	5.50±0.4
5	17.50±1.1	34.25±1.0	37.50±1.4	31.75±0.8
6	32.75±1.8	32.50±1.2	34.25±1.4	33.50±1.1
7	18.00±0.9	18.50±0.8	16.00±0.4	13.00±0.4
8	5.75±0.6	-	-	-
9	4.50±0.6	-	-	-
10	2.25±0.4	-	-	-
11	-	-	-	-
12	-	-	-	-
13	-	-	-	-
14	-	-	-	-
<b>Total</b>	80.75±1.1	90.00±1.1	92.25±1.0	83.75±1.5

Values: mean of 4 replicates.

germinated by day eight after sowing in comparison to the untreated, which extended to the tenth day. Germination of UC82B seeds soaked for 12 h was complete within a maximum of nine days after sowing (Table 3). For seeds soaked for 24 and 36 h, germination was completed within seven days from the date of sowing but untreated seeds lasted until the 11th day. For Xina,

seeds soaked for 24 and 36 h respectively completed germination within seven days (Table 4).

Total germination indicated that in Roma VF, 24 h soaking of seeds gave the highest germination of 98% followed by 36 h soaking, which gave 93.5% and 12 h which was 88%. Untreated seeds recorded only 70% (Table 2). Similarly, seeds of UC82B (Table 3) had the

**Table 5.** Effect of soaking duration on some growth parameters of Roma VF tomato.

Growth parameter	Soaking duration (h)			
	0	12	24	36
Plant height (cm)	10.02±1.4	13.18±0.7	15.16±0.4	9.53±0.2
No. Leaves	3.38±0.1	4.13±0.2	4.88±0.1	3.38±0.1
Stem diam. (mm)	1.97±0.32	2.27±0.42	2.59±0.42	1.97±0.32
Dry matter (g)	0.06±0.002	0.11±0.003	0.16±0.002	0.05±0.001

Values: mean of 4 replicates.

**Table 6.** Effect of soaking duration on some growth parameters of UC82B tomato.

Growth parameter	Soaking duration (h)			
	0	12	24	36
Plant height (cm)	13.00±2.8	15.05±2.3	16.05±0.7	11.75±1.6
No. Leaves	3.63±0.02	4.00±0.2	4.88±0.1	3.13±0.1
Stem diam. (mm)	2.08±0.39	2.43±0.40	2.79±0.46	1.93± 0.32
Dry matter (g)	0.06±0.001	0.12±0.002	0.14±0.002	0.06±0.001

Values: mean of 4 replicates.

**Table 7.** Effect of soaking duration on some growth parameters of Xina tomato.

Growth parameter	Soaking duration (h)			
	0	12	24	36
Plant height (cm)	9.35±0.30	10.15±0.30	9.85±1.5	9.95±0.5
No. Leaves	4.0±0.1	4.0±0.1	4.0±0.1	4.0±0.1
Stem diam. (mm)	1.91± 0.3	2.13±0.35	1.99±0.33	2.02 ±0.33
Dry matter (g)	0.076±0.001	0.079±0.001	0.078±0.002	0.078±0.001

Values: mean of 4 replicates.

highest germination after 24 h soaking (98.5%) followed by 36 h (96.25%) and 12 h (89.5%). Untreated seeds recorded only 71.25% germination. Seeds of Xina (Table 4) also recorded highest germination of 92.25% after 24 h soaking followed by 90% after 12 h soaking and 83.75% after 36 h. Untreated seeds recorded 80.75% germination.

Effects of seed soaking on seedling growth for the first two weeks after sowing are presented in Tables 5 - 7. In Roma VF (Table 5), 24 h soaking recorded the highest stem height, more number of leaves, thicker stem diameter and more dry matter content. This was followed by 12 h soaking in all the above parameters. Soaking of seeds for 36 h resulted in shorter stem height and less dry matter content in comparison to the seedlings from untreated seeds and about the same number of leaves and stem diameter. Variety UC82B (Table 6) performed best in all the growth parameters tested, from seeds soaked in water for 24 h, followed by those soaked for 12 h. Soaking of seeds for 36 h was injurious to growth since it was lower than the control in all parameters. Seeds of

Xina soaked for 12 h, recorded highest plant height, thicker stem diameter and more dry matter content. This was followed by soaking for 36 and 24 h, respectively.

## DISCUSSION

Seeds of the tomato varieties tested were of high viability as supported by the high percentage germination count of over 90%. John and Paul (1993), reported high percentage count as the bases for determining viability of seeds. The three varieties of tomato were of apparent similar size and were maintained under similar environmental conditions. Their variation in moisture content with Xina having about twice as much water as the other varieties may be attributed to genetic differences (Simpkins and Williams, 1990). Copeland (1976) reported variety difference as one of the reasons for differential water uptake by seeds. The intake of water in this variety may also be related to the relatively high moisture content of its dormant seeds which suggest that

cellular walls were not completely dry and had readily available openings to absorb more water.

Soaking treatment enhanced germination in all the seeds varieties tested. Highest performance in all the parameters and for all the varieties was recorded from seeds soaked for 24 hours. Seeds soaked for 36 hours gave the second best germination performance in terms of highest percentage and time of emergence except in Xina, where 12 hours treatment had higher percentage germination. However, in terms of the growth parameters 12 h soaking was next to 24 h in all the varieties. In fact, even the control was better than 36 h soaking in plant height and number of leaves in all varieties except in Roma VF and Xina where the number of leaves was the same. Thus suggesting harmful effect of excessive soaking. Seeds soaked for 36 h were better in dry matter content for Xina but less in UC82B and Roma VF. The high performance in 24 h soaking treatment suggest the seed require an optimal level of moisture rather than full saturation to activate the embryo to commence the process of cell division, differentiation and multiplication to grow into a seedling. Copeland (1976) observed that most seeds swollen in water and sown in moist environment, germinate faster than untreated seeds (Georghiou et. al., 1982, Yamaguchi, 1983) reported that seeds of tomato require adequate moisture for fast germination.

In the growth parameters of plant height, stem diameter thickness, leaf production and dry matter content, 36 h soaking of seeds seemed to be inhibitive being lowest or about same as the control except in Xina where there was a thicker stem diameter and more dry matter content. Prolong soaking was reported to increase carbon dioxide ethanol and lactic acids concentrations in seeds and reduced that of oxygen leading to poor growth (Irwin, 1982; Street and Helji, 1991). Poor aeration was reported to enhance formation of aerenchyma cells through the breakdown of inner cortical cells as is the case in many wetland species. In non-adaptive species, this development was reported to inhibit growth and development (Jackson, 1994). Other possible effects are leaching essential soluble food reserves in the seeds and exosmosis of enzymes and hormones lead to fall in protein synthesis and respiration rate (Copeland 1976, Street and Helji, 1991).

Optimal level of soaking is thought to have enhanced effects on germination and growth probably, due to hydrolysis of complex into simple sugars that are readily utilized in the synthesis of auxins and proteins. The auxins produced help to soften cell walls to facilitate growth and the proteins readily utilized in the production of new tissues.

In conclusion, soaking duration of tomato seeds has the potential to enhance germination and seedling growth. This procedure though simple and almost at no

cost, is capable of improving crop yield and boosting farmers income and is hereby recommended for adoption by farmers.

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