Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(4): 1400-1404
Received: 21-05-2020
Accepted: 22-06-2020

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Studies on standardization of water soaking duration on seed quality in cucumber (*Cucumis sativus* L.) seeds

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Abstract
A laboratory experiment entitled "standardization of water soaking duration on seeds quality in cucumber (*Cucumis sativus* L.) seeds" carried out at the department of seed science and technology, College of Agriculture, University of Agricultural Sciences Raichur, during 2018-19 using Completely Randomized Design with four replications. The factor of study consists of different water soaking durations (control, 6, 12, 18, 24, 30, 36, 42 and 48 h). The results showed that effect of water soaking duration significant on germination percentage, shoot length, root length, seedling dry weight seedling dry weight, seedling vigour I, seedling vigour index II, speed of germination, germination rate index and electrical conductivity in $P \leq 0.05$. Mean comparison showed that the highest germination percentage (89.00 %), shoot length (20.42 cm), root length (20.32 cm), seedling dry weight (479.75 mg), seedling vigour index I (3432), seedling vigour index II (40419), speed of germination (29.50) and germination rate index (2951) were achieved by 24 h water soaking (T_5) followed by 18 h of water soaking and lowest was recorded in control (T_1). Significantly highest (0.690 dSm^{-1}) electrical conductivity was recorded in control (T_1) and lowest (0.251 dSm^{-1}) was observed in 24 h of water soaking (T_5).

Keywords: water soaking, cucumber

Introduction
Cucumber (*Cucumis sativus* L.), also known by various Indian local names as Kamal kakdi (Hindi), Kakkari (Malayalam), Keera (Telugu), Vellarikkai (Tamil) belongs to the family Cucurbitaceae and it is a vital summer vegetable crop cultivated throughout India. Cucumber was originated in North West India where it is under cultivation since 3,000 years. Cucumber belongs to the genus *Cucumis* of which there are 20 to 25 species found mostly in Asia and Africa. Only two *Cucumis sativus* and *Cucumis melo* are of commercial importance in North America.

Cucumber is a monoecious seasonal vegetable; it is a sprawling vine with large leaves curling tendrils. The leaves are arranged alternately on the vines, the edge of the leaf blades has lobes or it has both teeth and lobes. Plant produces yellow colour flowers and having five petals and sepals. Yellow flowers are mostly either male or female. The female flowers are recognized by swollen ovary at the base, which will become an edible fruit. Fruits are usually cylindrical many seeded berries. Botanically the fruit is called as false berry or pepo. Its colour, size, shape varies according to the cultivar. Cucumber fruit has over 90 per cent water and when it is wrapped tightly by a plastic wrap, the fruit can retain moisture for a week to 10 days when stored properly in the refrigerated conditions.

Cucumber is warm season plant and grows best between 65º F to 75º F. The plants do not tolerate prolonged exposure to temperatures below 55º F or above 90º F. It is very sensitive to cold temperatures and may be killed at 1ºC. It has a minimum germination temperature of 16ºC, an optimum germination range of 16ºC to 35ºC, with an optimum germination temperature of 35ºC, and a maximum germination temperature of 40ºC. A well drained loam to sandy loam soil with a high organic matter with no frost pockets or problems with surface drainage is the ideal field situation. Wind protection either natural or artificial is necessary.

Cucumber is used as a fresh vegetable in the salad, pickles, daily cooking, cosmetic products and it has anti bacterial properties. Its fruits have a cooling effect and are used by patients suffering from jaundice, constipation and indigestion. The seed oil has antipyretic properties. High water content makes cucumbers a diuretic and it also has a cleansing action within the body by removing accumulated pockets of old waste material and chemical toxins. Cucumber helps to eliminate uric acid which is beneficial for those who have arthritis and its fiber rich skin and high levels of potassium and magnesium helps regulate blood pressure and help promote nutrient functions. The magnesium content in cucumbers also relaxes nerves, muscles and keeps blood circulating smoothly. The nutritive value of 100 g of edible cucumber contains 12 calorie of energy, 0.6 g of protein, 0.1 g of fat, 2.2 - 3.6 g of carbohydrates, 0.5 g of dietary fibre, 14 mg of Ca, 15 mg of Mg, 124 mg of K, 24 mg of P, 0.3 mg of Fe, 5 mg of Na, 0.2 mg of Zn. It is the most abundant source of vitamin A, vitamin B, B_1, B_2 and B_3.

High-quality seeds play an important role in a successful crop production programme. Rapid germination and emergence are essential for successful crop establishment, for which seed priming could play an important role. Seed priming is a pre-sowing strategy for influencing seedling development by modulating pre-germination metabolic activity prior to the emergence of the radicle and generally enhances rapid, uniform emergence and plant development to achieve higher yields (Mc Donald, 2000).

Material and Methods

The seed material of cucumber variety Swarna Sheetal used for the present investigation standardization of water soaking duration on seed quality in cucumber which was obtained from National Seeds Corporation, Secunderabad, Hyderabad. This experiment was carried out using a completely randomized design with nine treatments and four replications on germination in cucumber (*Cucumis sativus* L.) seeds at the department of seed science and technology, college of agriculture Raichur in 2018-19. The factor of study included different soaking duration (control, 6, 12, 18, 24, 30, 36, 42 and 48 h). The cleaned and graded seeds of cucumber variety Swarna sheetal were soaked in water with seed to solution ratio of 1:5 $g.mL^{-1}$(weight/volume) for different durations as per the treatments, after soaking seeds were drained from water and subsequently seeds were dried back to optimum moisture content of 7 per cent and then used for further testing of seed quality parameters by following standard germination test procedure of ISTA (2013) [21].

Germination (%)

The standard germination test was carried out by following between paper method as per ISTA procedure. Fifty seeds in eight replications were taken from each treatment and placed on germination paper uniformly. The roll towels were kept in germination chamber maintained at 25 ± 2°C temperature and 90 ± 5 percent relative humidity. Then the final count was taken on 8^{th} day. The number of normal seedlings from each replication was counted and the mean germination was expressed in percentage (ISTA, 2013) [21].

$$\text{Seed germination (\%)} = \frac{\text{Number of normal seedlings}}{\text{Total no. of seeds}} \times 100$$

Seedling vigour index (SVI)

The seedling vigour index-I and II were determined by employing the formula given by (Abdul-Baki and Anderson, 1973).

SVI-I = Germination (%) × Total seedling length (cm)

Whereas, SVI-II was calculated by using formula,

SVI-II = Germination (%) × Seedling dry weight (mg)

Speed of germination

Seeds were germinated on paper medium with eight replications of 50 seeds each and the daily germination counts were taken up to final count (8 days). The speed of germination was calculated by using the formula given by Maguire (1962) [26].

$$\text{Speed of germination} = \frac{G_1}{D_1} + \frac{G_2}{D_2} + \frac{G_3}{D_3} + \ldots\ldots\ldots\ldots + \frac{Gn}{Dn}$$

Where,

G_1, G_2, --- G_n are the number of seeds germinated on D_1, D_2, --- D_n day

Germination rate index (GRI)

For working out germination rate index, the procedure that was followed for germination test was used. However, the number of seeds that germinated were recorded on daily basis up to the day of final count for the respective crops. The germination rate index was worked out as suggested by Mudaris (1998) [29].

$$\text{Germination rate index} = \frac{G_1}{1} + \frac{G_2}{2} + \ldots\ldots\ldots + \frac{Gn}{n}$$

Where,

G_1: Germination percentage × 100 on 1^{st} day

G_n: Germination percentage × 100 on the n^{th} day

Electrical conductivity (dSm^{-1})

Five grams of seeds in four replications were soaked in acetone for half a minute and thoroughly washed in distilled water three times. Then, the seeds were soaked in 25 ml distilled water and kept in an incubator maintained at 25°C±1°C for 12 h. The seed leachate was collected and the volume was made up to 25 ml by adding distilled water. The electrical conductivity of the seed leachate was measured in the digital conductivity bridge (ELICO) with a cell constant 1.0 and the mean values were expressed in deci simons per meter (dSm^{-1}) (Milosevic *et al*., 2010) [28].

Results and Discussion

Seeds soaked in water for 24 h (T_5) recorded highest (84.3 %) seed germination followed by 18 h of water soaked (T_4) with 83.50 per cent. However, control (T_1) recorded lowest (76.3 %) seed germination. (Table 1). Soaking duration significantly affected the germination parameters with highest germination per cent observed in seeds soaked in water for 24 h. These results are in conformity with Uche *et al.*, 2016, who found that increased germination and vigour with 24 h of hydropriming is due to increased water uptake and rate of cell division in *Capsicum annuum*. The improved seed germination of hydroprimed seeds may be attributed to the improved physiologically active state of pre-germinated seeds due to priming (Matsushima and Sakagami, 2013) [27] as the metabolic process of seeds related to α-amylase activity is activated by water absorption with seed priming and the metabolic potential is preserved in the seed during the dry period after seed priming (Ando and Kobata, 2002) [3]. However, the positive effect of seed invigoration depends on priming duration (Ashraf and Foolad, 2005; Ghassemi-Golezani *et al*., 2008) [5, 15]. When seeds imbibe, the water content reaches a plateau and changes little until radicle emergence (Bradford, 1986) [8]. Priming up to this point can have a positive effect, while extended priming duration will negatively affect germination as mentioned in tomato.

The seed quality parameters reduced when soaked for less than 24 h (0, 6, 12 and 18 h) which is due to incomplete imbibition resulting in reduced activity of hydrolytic enzymes required for reserve mobilization of storage food (Perry and Harrison, 1974). Similar findings were given by Orzeszko-Rywka and Podlaski (2003) [31] in palak and Heydecker (1967) [20] in *Beta vulgaris.* Soaking of seeds for longer periods may have resulted in excess water been trapped within seed, causing suffocation and death of the embryo due to lack of oxygen (Finch-Savage *et al*., 2004) [30]. Furthermore, excess water uptake might have led to physiological seed damaging (Murungu, 2011).

Significantly highest shoot length, root length and seedling dry weight was observed in 24 h water soaking (T_5) (20.42 cm, 20.32 cm and 479.75 mg respectively) followed by 18 h of water soaking and lowest was recorded in control (T_1). (Table 1). The increase in shoot length with use of priming agent mainly due to the higher rate of cell division in the shoot tips incited by the application of hydropriming agent and these studies are in conformity with the work of Hajieghrari (2010) [17] while working on maize seeds. Kavitha (2009) [23] also observed the maximum shoot length in chilli seeds as compare to control. The increase in root length mainly due to metabolic repair of damage during treatment and that change in germination events *i.e*., changes in enzyme concentration and formation and reduction of lag time between imbibitions and radicle emergence Bradford (1990) [10] and hydroprimed seeds had stronger embryos that were able to emerge more easily from seeds Harris (2004) [18]. The increase in seedling dry weight mainly due to fact that larger seeds size was related to more seed food storages in their endosperm and increased cell division with the apical meristem, which increased plant growth (Basra *et al*., 2003) [7]. Significantly highest seedling vigour index I and II were observed in case of (T_5) seeds soaked in water for 24 h (3432 and 40419 respectively) followed by 18 h and lowest was recorded in control (T_1) (Table 2). The seedling vigour index increase mainly due to reduction of imbibitions lag time for priming treatments (Bradford, 1986) [9]. Priming also causes physiological and bio-chemical changes in seed during the seed treatments and metabolic activities increased amylase activity, thus resulted in higher seedling vigour index. The result showed that priming increased the vigour index of seed. These results were similar to those of Harris *et al*., (2000) [19], Lee and Kim (2000) [25] and Basra *et al*. (2003) [7] in rice crop. The reason for poor seed vigour of unprimed seed may be due to a slower rate of imbibitions. Hydropriming of seeds stand first in respect to seedling vigour index. The better seedling vigour is due to significant improvement in germination and seedling dry weight. Germination is an enzymatic reaction and is strongly correlated with activities present in the seed. Hydropriming might be increased the enzymatic activities during seed germination and enhance the seedling vigour.

With respect to speed of germination and germination rate index seeds soaked in water for 24 h (T_5) recorded significantly highest (29.50 and 2951 respectively) followed by 18 h and lowest was recorded in control (T_1) (Table 3). In general, cycles of hydropriming increased normal seedling percentage when seeds germinated in distilled water. Agreeing with these findings, one cycle of hydropriming was efficient to speed up and increase germination in cucumber cultivars Hatuey-1 and Japones (Sanchez *et al*., 1997). In bean cv. Carioca seeds, hydropriming was favorable, providing faster germination Aragao *et al*. (2002) [4].

The faster germination rate index was obtained by soaking seeds in water, probably due to quick water uptake and earlier initiation of metabolic process which determine radicle protrusion. The earlier germination is positively correlated with germination rate index. Generally earlier germination occurred due to higher synthesis of DNA, RNA and protein during priming. These results are in conformity with the findings of Bray *et al*. (1989) [12] in leek seeds. The rate of germination mainly due to bolder seeds that contains greater metabolites for consumption of embryonic growth during germination as reported by Kumar and Uppar (2007) [24] in moth bean.

Biochemical parameter like electrical conductivity significantly highest was recorded in control (T_1) (0.690 dSm^{-1}) and lowest (0.251 dSm^{-1}) was observed in seeds soaked in water for 24 h (T_5) (Table 3). Generally, electrical conductivity indicates the membrane integrity and quality of the seeds. Lower the EC, higher the membrane integrity and seed quality. The increased electrical conductivity in control may be rapid loss of electrolytes from the seed and damage to membrane during imbibition hence loss in selective permeability of cellular membrane. That causes increase in the seed leachates and decrease in the enzyme activity. Hydropriming for 24 h improved the seed quality. This improvement was reflected in low electrical conductivity of seed leachates and higher germination percentage and seedling dry weight. The low electrical conductivity for primed seed may be due to better plasma membrane structure by slow hydration. Similar results were reported for wheat (Basra *et al*., 2003) [7] and barley Abdulrahmani *et al*. (2007) [2]. It was found that seed priming causes metabolic changes in germinating seed, such as cell cycle related events, (De Castro *et al*., 2000) [13], endosperm weakening by hydrolase activities (Groot *et al*., 1987; Bradford *et al*., 2000) [16, 11] and mobilization of storage proteins Job *et al*. (2000) [22].

Table 1: Effect of water soaking duration on seed germination, shoot length, root length and seedling dry weight in cucumber seeds

Treatments	Germination (%)	Shoot length (cm)	Root length (cm)	Seedling dry weight (mg)
T_1 - Without soaking (Control)	76.3	11.31	11.21	432.50
T_2 - Seeds soaking in water for 6 h	81.3	16.42	15.36	462.75
T_3 - Seeds soaking in water for 12 h	82.8	18.35	17.69	464.25
T_4 - Seeds soaking in water for 18 h	83.5	19.34	19.29	470.75
T_5 - Seeds soaking in water for 24 h	84.3	20.42	20.32	479.75
T_6 - Seeds soaking in water for 30 h	82.5	19.08	18.54	465.75
T_7 - Seeds soaking in water for 36 h	81.5	17.68	17.63	463.75
T_8 - Seeds soaking in water for 42 h	77.0	16.24	14.79	459.00
T_9 - Seeds soaking in water for 48 h	76.8	11.68	11.38	438.25
MEAN	80.64	16.72	16.25	459.64
S.Em±	0.32	0.10	0.18	0.76
CD @ 1%	1.24	0.39	0.71	2.97

Table 2: Effect of water soaking duration on seedling vigour index I and II in cucumber seeds

Treatments	Seedling vigour index I	Seedling vigour index II
T_1 - Without soaking (Control)	1717	32979
T_2 – Seeds soaking in water for 6 h	2583	37599
T_3 – Seeds soaking in water for 12 h	2982	38416
T_4 – Seeds soaking in water for 18 h	3226	39308
T_5 - Seeds soaking in water for 24 h	3432	40419
T_6 - Seeds soaking in water for 30 h	3103	38425
T_7 - Seeds soaking in water for 36 h	2878	37796
T_8 - Seeds soaking in water for 42 h	2389	35343
T_9 – Seeds soaking in water for 48 h	1769	33636
MEAN	2676	37102
S.Em±	20.0	158
CD @ 1%	78	617

Table 3: Effect of water soaking duration on speed of germination, germination rate index and electrical conductivity in cucumber seeds

Treatment	Speed of germination	Germination rate index	Electrical conductivity (dSm^{-1})
T_1 - Without soaking (Control)	25.84	2585	0.690
T_2 - Seeds soaking in water for 6 h	28.30	2831	0.458
T_3 - Seeds soaking in water for 12 h	29.06	2907	0.367
T_4 - Seeds soaking in water for 18 h	29.07	2908	0.287
T_5 - Seeds soaking in water for 24 h	29.50	2951	0.251
T_6 - Seeds soaking in water for 30 h	28.55	2856	0.421
T_7 - Seeds soaking in water for 36 h	28.55	2856	0.450
T_8 - Seeds soaking in water for 42 h	26.98	2699	0.564
T_9 - Seeds soaking in water for 48 h	25.86	2587	0.685
MEAN	27.97	2798	0.464
S.Em±	0.33	32.69	0.007
CD @ 1%	1.28	128.09	0.027

Conclusions

Among the various duration of water soaking, 24 h duration was found to be effective for hydropriming. 24 h of water soaking enhanced all the seed quality parameters.

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