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## Studies on duration of seed dormancy and dormancy breaking methods on seed quality in cucumber (*Cucumis sativus* L.) seeds

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**Abstract**

The laboratory experiment was conducted during 2018-19 having 19 treatments with 4 replications planned with CRD design. Freshly harvested cucumber variety Swarna Sheetal seeds were exposed to various physico-chemical dormancy breaking methods. For physical methods seeds were exposed to a different treatments and duration. For chemical treatments, soaking duration was 24 h. Results revealed that exposure of cucumber seeds to a hot dry air treatment at 70 °C for 3 days (T<sub>11</sub>) showed significantly highest (90.25%) normal seedling per cent, shoot length (14.42 cm), root length (21.07 cm), seedling dry weight (725.00 mg), seedling vigour index-I (3202), seedling vigour index-II (65432) and dehydrogenase enzyme activity (0.051 OD value) compared to other treatments and control and it was found on par with thiourea @ 0.5% (T<sub>16</sub>). However, significantly highest (0.634 dSm<sup>-1</sup>) electrical conductivity recorded in control (T<sub>1</sub>) and lowest (0.227 dSm<sup>-1</sup>) in hot dry air treatment at 70 °C for 3 days (T<sub>11</sub>). For duration of seed dormancy results showed that cucumber variety "Swarna Sheetal" exists up to 35 to 40 days after harvest with germination per cent of 61.25 to 63.50% respectively.

**Keywords:** Dormancy, germination, hot dry air treatment, cucumber

**Introduction**

Cucumber is a monoecious seasonal vegetable crop it is a sprawling vine with large leaves curling tendrils. It belongs to family Cucurbitaceae. Cucumber is a typical example of fruit with shallow dormancy. The seeds normally germinate a few days after being extracted from freshly harvested mature fruits, undergo a period of dormancy until the proper environment for survival is present. Primary dormancy is generally used to describe an intact freshly-harvested viable seed that cannot germinate in favorable conditions (Bewley, 1997) [5]. Dormancy breaking is necessary if the seeds are planted immediately after harvest. Various methods are being employed in many crops for breaking seed dormancy such as warm stratification, chilling

(cold stratification), light, or hormones (including gibberellins; Kucera *et al.*, 2005; Miransari and Smith, 2014) [19, 26] can release seeds from primary dormancy. Non-dormant seeds can also re-enter dormancy, known as secondary dormancy, to avoid unfavorable conditions such as season changes (Finkelstein *et al.*, 2008) [12]. The breaking of seed dormancy to establish seedling growth is a critical step in the life of seed plants. The regulation of this developmental transition is not only necessary for plant survival but also important for agriculture and forestry. Seed dormancy in cucumber is a varietal characteristic. Dormancy is known to occur in many types of seeds. It is a mechanism for the survival but its presence could also give problem in seed testing and research work. Dormancy in cucumber is the temporary arrest of seed development before completion of their maturation process hence it requires post harvest ripening duration for complete development of embryo so as to get the maximum germination after the harvest of the crop. Knowledge on the various seed dormancy breaking methods is very much useful to the farmer who takes up seed production or crop production immediately after harvest. Keeping in view of the above aspects, the present investigation was taken up with cucumber variety Swarna Sheetal to overcome the seed dormancy by various dormancy breaking methods. Hot dry air treatment break the impermeability of nucellar membrane, promoting oxygen intake and imbibition of water thereby breaking dormancy. Heat treatment possibly helped in overcoming the restriction of availability of oxygen to the embryo there by it increases germination.

Thiourea acts on seed coat and increase cytokinin activity to overcome inhibition that leads to stimulate seed germination Cetinbas *et al.* (2006)<sup>[10]</sup>. Thiourea acts as a light substitute to enhance the germination. Through this study, a cost effective dormancy breaking treatment can be provided to the farming community so as to avoid delay in sowing. Dormancy breaking treatments are required for faster breeder seed production as well.

### Material and methods

The seed material of cucumber variety Swarna Sheetal used for the present investigation to know the duration of seed dormancy and the effect of dormancy breaking methods on seed quality which was obtained from National Seeds Corporation, Secunderabad, Hyderabad. The laboratory experiment was carried out at the department of Seed Science and Technology, College of agriculture Raichur, University of Agricultural Science, Raichur during the year 2018-19 and data was analyzed using Completely Randomized Design with four replications. The fresh seeds of cucumber variety Swarna Sheetal were extracted from mature fruits grown during September 2018. The half filled and empty seeds, which floated when soaked in water, were discarded seeds were washed to remove the mucilage coat on the seeds and tested for germination as per ISTA (2013)<sup>[14]</sup> rules to assess duration of seed dormancy from immediately after harvest (0<sup>th</sup> day) up to 40 days after harvest with five days of interval.

### Seed 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  $25 \pm 2$  °C temperature and  $90 \pm 5$  percent relative humidity. Then the final count was taken on 8<sup>th</sup> day. The number of normal seedlings from each replication was counted and the mean germination was expressed in percentage (ISTA, 2013)<sup>[14]</sup>.

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

For dormancy breaking the following various physical and chemical dormancy breaking treatments were imposed to break the dormancy of freshly harvested seeds.

T<sub>1</sub>: Control

T<sub>2</sub>: Cooling in a deep freezer for two days

T<sub>3</sub>: Cooling in a deep freezer for four days

T<sub>4</sub>: Water soaking for 12 h

T<sub>5</sub>: Water soaking for 24 h

T<sub>6</sub>: Hot water treatment at 50 °C for 10 minutes

T<sub>7</sub>: Hot water treatment at 60 °C for 40 minutes

T<sub>8</sub>: Sun drying for 24 h

T<sub>9</sub>: Sun drying for 48 h

T<sub>10</sub>: Hot dry air treatment for 50 °C for two days

T<sub>11</sub>: Hot dry air treatment for 70 °C for three days

T<sub>12</sub>: Soaking in KNO<sub>3</sub> @ 0.4%

T<sub>13</sub>: Soaking in KNO<sub>3</sub> @ 0.6%

T<sub>14</sub>: Soaking in GA<sub>3</sub> @ 500 ppm

T<sub>15</sub>: Soaking in GA<sub>3</sub> @ 1000 ppm

T<sub>16</sub>: Soaking in Thiourea @ 0.5%

T<sub>17</sub>: Soaking in Thiourea @ 1.0%

T<sub>18</sub>: Soaking in Ethrel @ 50 ppm

T<sub>19</sub>: Soaking in Ethrel @ 100 ppm

For the physical methods exposed the seeds to the respective treatments for respective duration and for the chemical treatments, soaking duration was 24 h and the treated cucumber seeds were surface dried and tested for germination. Seeds were germinated in petri dishes with a diameter of 9 cm containing three sheets of filter paper moistened initially. Each treatment was replicated four times. The petri dishes were kept in growth chamber for 8 days at  $25 \pm 2$  °C. The germination was recorded on 8<sup>th</sup> day and based on normal seedlings produced. The germination percentage was worked out.

### Seedling vigour index (SVI)

The seedling vigour index-I and II were determined by employing the formula given by (Abdul-Baki and Anderson, 1973)<sup>[11]</sup>.

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

Whereas, SVI-II was calculated by using formula,

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

### Electrical conductivity (dSm<sup>-1</sup>)

For determining electrical conductivity of seed leachates 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  $25 \pm 1$  °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<sup>-1</sup>) (Milosevic *et al.*, 2010)<sup>[25]</sup>.

### Dehydrogenase enzyme activity (OD value)

Dehydrogenase enzyme activity was reported as the optical density (OD) value obtained as suggested by Shenoy *et al.* (1990)<sup>[34]</sup>. Representative sample of 25 seeds were taken from each treatment and preconditioned by soaking in water for 18 h at room temperature. Seeds were taken randomly, remove the wings and cut through the midsection of distal end and expose the embryonic axis. Then the seeds were steeped in one per cent solution of 2, 3, 5 - triphenyl tetrazolium chloride (TZ) and kept in dark for 24 h for staining. Later on, the stained seeds were thoroughly washed with distilled water and soaked in 10 ml of methoxy ethanol (methyl cellosolve) solution overnight for destaining or extracting red colour. The intensity of red colour was measured using ELICO UV-VIS spectrophotometer using blue filter at 480 nm with methoxy ethanol as the blank. The OD value obtained was reported as the dehydrogenase enzyme activity (Kittock and Law, 1968)<sup>[17]</sup>. The mean values of the data were statistically analyzed following completely randomized design (CRD).

### Results and discussion

The germination was about 0 per cent when tested immediately after the harvest (0<sup>th</sup> day) which increased steadily from 0 to 63.5 per cent after 40 days of harvest which was above the Minimum Seed Certification Standards (60%) indicating complete release of dormancy. This suggested that the period of dormancy in cucumber variety Swarna Sheetal seeds was upto 40 days after harvest (Table 1). Similar findings were noticed by Lambat *et al.* (2015)<sup>[21]</sup> in cucumber cv. Shital, the seed germination percent was about 30 per cent immediately after harvesting (0 day of testing) which released steadily from 30 to 96 per cent after 49 days indicating

complete release of dormancy. The results are in conformity with Vanden Born (1993) [39] reported that in coriander seed exhibits complete or near complete dormancy in freshly harvested seeds and dormancy was broken after three to six weeks. Bosland and Votava, (2000) [7] observed that the freshly harvested seeds of wild capsicum species exhibited dormancy for 40-45 days after harvest. Randle and Homna, (1981) [31] in chilli seeds required an after ripening period of 45 days to release dormancy.

The cucumber seeds were exposed to various pre-treatments to break dormancy which showed significant differences on seed physiological parameters while lowest seed physiological parameters were found in untreated seeds, which indicates different pre-treatments are necessary to overcome the dormancy and to improve the seedling emergence and uniform plant stand.

The exposure of the cucumber seeds to a hot dry air treatment at 70 °C for three days (T<sub>11</sub>) recorded significantly highest (90.25%) normal seedling per cent followed by thiourea @ 0.5 per cent (87.25%) and sun drying for 48 h (81.25%) and lowest (28.25%) was observed in control (T<sub>1</sub>) (Table 2). These results are in conformity with the findings of Temiesagdie *et al.* (1991) [36] in cucumber. Mainly hot dry air treatment appeared to break the impermeability of nucellar membrane, promoting oxygen intake and imbibition of water thereby breaking dormancy. This increased germination due to heat treatment possibly helped in overcoming the restriction of availability of oxygen to the embryo or reducing the peroxidase activity in the seed covering structures thereby promoting the degradation and evaporation of short chain saturated fatty acids (SCSFAs) from the dormant seeds thereby increasing the germinability. This confirms the earlier findings of Kota *et al.* (2006) [18], who suggested dry heat treatment and Abdul *et al.* (2012) [2], who observed increase in germination of hulled rice seeds after heat treatment at 50 °C in rice cultivars. Earlier reports showed that the nucellar membrane contributed to the impermeability (Brown, 1940) [8], while intact inner integument was responsible for maintaining the dormancy in cucumber Nawab *et al.* (1991) [29].

Seeds treated with thiourea @ 1 per cent (T<sub>17</sub>) recorded highest (11%) per cent of abnormal seedlings followed by seeds treated with thiourea @ 0.5 per cent (T<sub>16</sub>) (5.50%). However, seeds exposure to a hot dry air treatment at 70 °C for three days (T<sub>11</sub>) showed lowest (0.25%) number of abnormal seedlings (Table 2). The increased abnormal seedlings percent in case of thiourea treated seeds mainly due to the stimulating inhibitory effects of thiourea due to the action on the storage materials of the seeds (Phosphate oxygen ratio) and the coupling action in germinating seeds either directly or indirectly, This view is supported by Jaris *et al.* 1968 [16] in hazel seeds, (Bryant, 1985) [9] and (Mayer and Poljakoff-Mayber, 1989) [24]. These findings were in similar with (Vanangamudi *et al.*, 2014) [38] in kalmegh: Medicinal seeds and plants.

Significantly highest 64.50 per cent of fresh un-germinated seeds were noticed in control (T<sub>1</sub>) followed by seeds treated with KNO<sub>3</sub> at 0.4 per cent (T<sub>12</sub>) (58.75%). However lowest (2.00%) fresh un-germinated seeds were obtained in seeds exposed to a hot dry air treatment at 70°C for three days (T<sub>11</sub>) (Table 2). The freshly harvested seeds of some cucurbits face the problem of dormancy. The freshly harvested seeds are not capable of germinating due to rudimentary embryo or immaturity of seeds due to this reason fresh un-germinated seeds were found during the germination test period. Some

chemicals and growth regulators like KNO<sub>3</sub>, GA<sub>3</sub>, IBA and IAA successfully break the dormancy in fresh un-germinated seeds and can improve the number of normal seedlings at the time germination test period (Kumar and Sastry, 1974, Mohammad *et al.*, 1984, Reddy and Swamy, 1976, Singh *et al.*, 1992 and Tiwari *et al.*, 2001) [20, 28, 32, 35, 37]. These results are in similar with the findings of Bijendra *et al.* (2018) [6] in freshly harvested seeds of linseed.

Seeds exposed to a hot dry air treatment at 70 °C for three days (T<sub>11</sub>) has shown highest (7.50%) per cent of dead seeds which was on par with hot dry air treatment at 50°C for 2 days (T<sub>10</sub>), ethrel at 50 ppm (T<sub>18</sub>), thiourea at 1.0 per cent (T<sub>17</sub>) and water soaking for 12 h (T<sub>4</sub>) recorded 7.25, 6.75, 6.50 and 6.25 per cent of dead seeds respectively. However, significantly lowest (1.50%) numbers of dead seeds were obtained in cooling in a deep freezer for 4 days (T<sub>3</sub>) (Table 2). The more number of dead seeds was observed in heat treatment for 3 days at 70 °C may be due to presence of dead embryo and endosperm due to excessive heat exposure. The results are in conformity with Janaiah *et al.* (2006) [15] and Abdul Waheed *et al.* (2012) [3] in bitter gourd.

Significantly highest shoot length, root length and seedling length (14.42 cm, 21.07 cm and 35.48 cm respectively) were observed in case of exposure of cucumber seeds to a hot dry air treatment at 70 °C for three days (T<sub>11</sub>). However lowest was observed in control (T<sub>1</sub>) (Table 3). Hot air treatment has been reported to enhance germination and emergence by affecting various factors, viz., seed coat permeability for water to maximize the seed hydration (Longer and Degago, 1996) [23], for gaseous exchange and release of inhibitors (Mohamed- Yaseen *et al.*, 1994) [27] like phenols. Exposing the seeds to a high temperature soften the seeds coat (Farooq *et al.*, 2007) [11] that allow water and air to permeate the tissues in order to enhance the physiological changes and the subsequent germination of the embryo according to Sabongari (2001) [33].

Similarly with respect to seedling dry weight, seedling vigour index-I and II were significantly highest (725.00 mg, 3202 and 65432 respectively) in hot dry air treatment at 70 °C for three days (T<sub>11</sub>) when compared with all other treatments and control (T<sub>1</sub>) (Table 4). Seedling dry weight was increased due to increased root length and shoot length. The increase in seedling vigour index I and II might be due to increase in seedling length, germination and dry weight. Hot dry air treatment at 70 °C for three days could increase germination and proved good growing characteristics in either vegetative or generative organs. This is mainly due to temperature treatments, as temperature did not affect seed imbibition behaviour. There was no deterioration effect detected with increasing heat treatment duration up to 70 °C for three days. Highest (0.634 dSm<sup>-1</sup>) electrical conductivity of seed leachates was noticed in control (T<sub>1</sub>) and lowest (0.227 dSm<sup>-1</sup>) in hot dry air treatment at 70 °C for three days (T<sub>11</sub>) followed by seed treatment with thiourea @ 0.5 per cent (0.228 dSm<sup>-1</sup>) and sun drying for 48 h (0.269 dSm<sup>-1</sup>) at 1% level of significance (Table 5). Similar results were also reported by Liela *et al.* (2005) [22] in paddy for thermal hardening treatment. The seed germination vigour of weak and strong germinating seeds mainly depends on electrical conductivity which may indicate a degree of plasma membrane permeability. The weak germinating seeds experienced the greatest ion leakage from seed cells while very well germinating seeds showed the lowest ion efflux. Similar findings were obtained by Plazek, *et al.* (2018) [30] in *Lupinus angustifolius*.

Similarly dehydrogenase enzyme activity was also enhanced in all the dormancy breaking treatments. But enzyme activity was highest (0.051) in case of seeds exposed to a hot dry air treatment at 70 °C for three days (T<sub>11</sub>) followed by thiourea at 0.5 per cent (0.049) and sun drying for 48 h (0.048) when compared with control (0.015) (Table 5). The results emphasized that dehydrogenase enzyme activity is an important indicator of breaking dormancy in seeds and also an efficient indicator of the degree of dormancy. Antonio *et al.* (2002) [4]. It is postulated that release from dormancy is associated with an increased activity of pentose phosphate pathway (PPP) dehydrogenases (Hendricks and Taylorson, 1974) [13] as catalases and PPP activity is more during germination due to increased respiration, hydrolysis of stored food materials and energy synthesis. The present study also

confirms that dehydrogenase activity is increased in all the dormancy breaking treatments.

**Table 1:** Duration of seed dormancy in cucumber

| Days  | Seed germination (%) |
|---|----------------------|
| T <sub>1</sub> - at 0 <sup>th</sup> day (Immediately after the harvest) | 0.0                  |
| T <sub>2</sub> - Five days after harvest                                | 2.8                  |
| T <sub>3</sub> - 10 days after harvest                                  | 8.0                  |
| T <sub>4</sub> - 15 days after harvest                                  | 40.5                 |
| T <sub>5</sub> - 20 days after harvest                                  | 50.5                 |
| T <sub>6</sub> - 25 days after harvest                                  | 57.0                 |
| T <sub>7</sub> - 30 days after harvest                                  | 59.8                 |
| T <sub>8</sub> - 35 days after harvest                                  | 61.3                 |
| T <sub>9</sub> - 40 days after harvest                                  | 63.5                 |

**Table 2:** Effect of dormancy breaking methods on normal seedlings, abnormal seedlings, fresh un-germinated seeds and dead seeds in cucumber

| Treatments  | Normal seedlings (%) | Abnormal seedlings (%) | Fresh un germinated seeds (%) | Dead seeds (%) |
|---|----------------------|------------------------|-------------------------------|----------------|
| T <sub>1</sub> - Control                                | 28.25                | 4.50                   | 64.50                         | 2.75           |
| T <sub>2</sub> - Cooling in a deep freezer for 2 days   | 40.25                | 1.25                   | 56.50                         | 2.00           |
| T <sub>3</sub> - Cooling in a deep freezer for 4 days   | 59.50                | 2.00                   | 37.00                         | 1.50           |
| T <sub>4</sub> - Water soaking 12 h                     | 41.75                | 4.25                   | 47.75                         | 6.25           |
| T <sub>5</sub> - Water soaking 24 h                     | 52.25                | 5.50                   | 39.25                         | 3.00           |
| T <sub>6</sub> - Hot water treatment at 50 °C 10 min    | 69.50                | 4.75                   | 20.50                         | 5.25           |
| T <sub>7</sub> - Hot water treatment at 60 °C 40 min    | 34.75                | 3.75                   | 58.00                         | 3.50           |
| T <sub>8</sub> - Sun drying 24 h                        | 73.75                | 2.00                   | 19.50                         | 4.75           |
| T <sub>9</sub> - Sun drying 48 h                        | 81.25                | 2.50                   | 13.25                         | 3.00           |
| T <sub>10</sub> - Hot dry air treatment at 50 °C 2 days | 58.25                | 4.00                   | 30.50                         | 7.25           |
| T <sub>11</sub> - Hot dry air treatment at 70 °C 3 days | 90.25                | 0.25                   | 2.00                          | 7.50           |
| T <sub>12</sub> - KNO <sub>3</sub> at 0.4%              | 34.00                | 2.00                   | 58.75                         | 5.25           |
| T <sub>13</sub> - KNO <sub>3</sub> at 0.6%              | 61.50                | 1.50                   | 33.75                         | 3.25           |
| T <sub>14</sub> - GA <sub>3</sub> at 500 ppm            | 48.00                | 2.00                   | 47.50                         | 2.50           |
| T <sub>15</sub> - GA <sub>3</sub> at 1000 ppm           | 51.75                | 3.25                   | 39.25                         | 5.75           |
| T <sub>16</sub> - Thiourea at 0.5%                      | 87.25                | 5.50                   | 4.50                          | 2.75           |
| T <sub>17</sub> - Thiourea at 1.0%                      | 76.50                | 11.00                  | 6.00                          | 6.50           |
| T <sub>18</sub> - Ethrel at 50 ppm                      | 34.50                | 4.25                   | 54.50                         | 6.75           |
| T <sub>19</sub> - Ethrel at 100 ppm                     | 52.50                | 2.00                   | 42.50                         | 3.00           |
| Mean  | 56.62                | 3.49                   | 35.55                         | 4.34           |
| S.Em±   | 0.78                 | 0.48                   | 0.78                          | 0.47           |
| CD @ 1%   | 2.91                 | 1.80                   | 2.93                          | 1.77           |

**Table 3:** Effect of dormancy breaking methods on shoot length, root length and seedling length in cucumber

| Treatments  | Shoot length (cm) | Root length (cm) | Seedling length (cm) |
|---|-------------------|------------------|----------------------|
| T <sub>1</sub> - Control                                    | 9.34              | 9.71             | 19.05                |
| T <sub>2</sub> - Cooling in a deep freezer for 2 days       | 11.94             | 11.45            | 23.39                |
| T <sub>3</sub> - Cooling in a deep freezer for 4 days       | 10.51             | 11.11            | 21.62                |
| T <sub>4</sub> - Water soaking for 12 h                     | 10.23             | 11.46            | 21.69                |
| T <sub>5</sub> - Water soaking for 24 h                     | 11.92             | 12.92            | 24.83                |
| T <sub>6</sub> - Hot water treatment at 50 °C for 10 min    | 11.22             | 12.27            | 23.49                |
| T <sub>7</sub> - Hot water treatment at 60 °C for 40 min    | 11.61             | 14.48            | 26.09                |
| T <sub>8</sub> - Sun drying for 24 h                        | 12.11             | 18.11            | 30.21                |
| T <sub>9</sub> - Sun drying for 48 h                        | 13.67             | 19.69            | 33.36                |
| T <sub>10</sub> - Hot dry air treatment at 50 °C for 2 days | 12.63             | 18.43            | 31.06                |
| T <sub>11</sub> - Hot dry air treatment at 70 °C for 3 days | 14.42             | 21.07            | 35.48                |
| T <sub>12</sub> - KNO <sub>3</sub> @ 0.4%                   | 13.30             | 16.53            | 29.83                |
| T <sub>13</sub> - KNO <sub>3</sub> @ 0.6%                   | 12.18             | 16.36            | 28.53                |
| T <sub>14</sub> - GA <sub>3</sub> @ 500 ppm                 | 8.52              | 17.11            | 25.63                |
| T <sub>15</sub> - GA <sub>3</sub> @ 1000 ppm                | 8.04              | 18.20            | 26.24                |
| T <sub>16</sub> - Thiourea @ 0.5%                           | 13.87             | 19.73            | 33.60                |
| T <sub>17</sub> - Thiourea @ 1.0%                           | 13.02             | 19.48            | 32.49                |
| T <sub>18</sub> - Ethrel @ 50 ppm                           | 12.06             | 17.83            | 29.89                |
| T <sub>19</sub> - Ethrel @ 100 ppm                          | 13.31             | 17.01            | 30.32                |
| Mean  | 11.78             | 15.94            | 27.73                |
| S.Em±   | 0.38              | 0.41             | 0.63                 |
| CD @ 1%   | 1.42              | 1.53             | 2.40                 |

**Table 4:** Effect of dormancy breaking methods on seedling dry weight, seedling vigour index I and II in cucumber

| Treatments  | Seedling dry weight (mg) | Seedling vigour index I | Seedling vigour index II |
|---|--------------------------|-------------------------|--------------------------|
| T <sub>1</sub> - Control                                    | 299.00                   | 538                     | 8447                     |
| T <sub>2</sub> - Cooling in a deep freezer for 2 days       | 440.75                   | 942                     | 17740                    |
| T <sub>3</sub> - Cooling in a deep freezer for 4 days       | 330.25                   | 1286                    | 19649                    |
| T <sub>4</sub> - Water soaking for 12 h                     | 403.75                   | 905                     | 16856                    |
| T <sub>5</sub> - Water soaking for 24 h                     | 473.00                   | 1297                    | 24715                    |
| T <sub>6</sub> - Hot water treatment at 50 °C for 10 min    | 452.00                   | 1634                    | 31416                    |
| T <sub>7</sub> - Hot water treatment at 60 °C for 40 min    | 513.00                   | 908                     | 17826                    |
| T <sub>8</sub> - Sun drying for 24 h                        | 614.00                   | 2228                    | 45282                    |
| T <sub>9</sub> - Sun drying for 48 h                        | 695.00                   | 2710                    | 56468                    |
| T <sub>10</sub> - Hot dry air treatment at 50 °C for 2 days | 658.75                   | 1809                    | 38371                    |
| T <sub>11</sub> - Hot dry air treatment at 70 °C for 3 days | 725.00                   | 3202                    | 65432                    |
| T <sub>12</sub> - KNO <sub>3</sub> @ 0.4%                   | 555.75                   | 1014                    | 18897                    |
| T <sub>13</sub> - KNO <sub>3</sub> @ 0.6%                   | 544.00                   | 1758                    | 33456                    |
| T <sub>14</sub> - GA <sub>3</sub> @ 500 ppm                 | 510.25                   | 1230                    | 24494                    |
| T <sub>15</sub> - GA <sub>3</sub> @ 1000 ppm                | 517.25                   | 1358                    | 26768                    |
| T <sub>16</sub> - Thiourea @ 0.5%                           | 709.75                   | 2931                    | 61927                    |
| T <sub>17</sub> - Thiourea @ 1.0%                           | 683.75                   | 2486                    | 52308                    |
| T <sub>18</sub> - Ethrel @ 50 ppm                           | 555.75                   | 1031                    | 19172                    |
| T <sub>19</sub> - Ethrel @ 100 ppm                          | 618.25                   | 1593                    | 32458                    |
| Mean  | 542.07                   | 1624                    | 32194                    |
| S.Em±   | 0.89                     | 45                      | 434                      |
| CD @ 1%   | 3.37                     | 170                     | 1635                     |

**Table 5:** Effect of dormancy breaking methods on electrical conductivity and dehydrogenase enzyme activity in cucumber seeds

| Treatments  | Electrical conductivity (dSm <sup>-1</sup> ) | Dehydrogenase enzyme activity (OD value) |
|---|--|--|
| T <sub>1</sub> - Control                                    | 0.634  | 0.015                                    |
| T <sub>2</sub> - Cooling in a deep freezer for 2 days       | 0.523  | 0.026                                    |
| T <sub>3</sub> - Cooling in a deep freezer for 4 days       | 0.354  | 0.035                                    |
| T <sub>4</sub> - Water soaking for 12 h                     | 0.520  | 0.026                                    |
| T <sub>5</sub> - Water soaking for 24 h                     | 0.428  | 0.027                                    |
| T <sub>6</sub> - Hot water treatment at 50 °C for 10 min    | 0.331  | 0.042                                    |
| T <sub>7</sub> - Hot water treatment at 60 °C for 40 min    | 0.525  | 0.025                                    |
| T <sub>8</sub> - Sun drying for 24 h                        | 0.324  | 0.044                                    |
| T <sub>9</sub> - Sun drying for 48 h                        | 0.269  | 0.048                                    |
| T <sub>10</sub> - Hot dry air treatment at 50 °C for 2 days | 0.360  | 0.033                                    |
| T <sub>11</sub> - Hot dry air treatment at 70 °C for 3 days | 0.227  | 0.051                                    |
| T <sub>12</sub> - KNO <sub>3</sub> @ 0.4%                   | 0.625  | 0.022                                    |
| T <sub>13</sub> - KNO <sub>3</sub> @ 0.6%                   | 0.343  | 0.039                                    |
| T <sub>14</sub> - GA <sub>3</sub> @ 500 ppm                 | 0.520  | 0.027                                    |
| T <sub>15</sub> - GA <sub>3</sub> @ 1000 ppm                | 0.480  | 0.027                                    |
| T <sub>16</sub> - Thiourea @ 0.5%                           | 0.228  | 0.049                                    |
| T <sub>17</sub> - Thiourea @ 1.0%                           | 0.282  | 0.046                                    |
| T <sub>18</sub> - Ethrel @ 50 ppm                           | 0.537  | 0.022                                    |
| T <sub>19</sub> - Ethrel @ 100 ppm                          | 0.420  | 0.029                                    |
| Mean  | 0.417  | 0.033                                    |
| S.Em±   | 0.0054                                       | 0.0003                                   |
| CD @ 1%   | 0.0203                                       | 0.0010                                   |

## Conclusion

The duration of seed dormancy in cucumber variety “Swarna Sheetal” exists up to 35 to 40 days after harvest with germination percent of 61.25 to 63.50 per cent respectively which was above the Minimum Seed Certification Standards (60%). Among the different dormancy breaking treatments exposure of cucumber seeds to a hot dry air treatment at 70 °C for three days showed significantly highest normal seedling per cent, shoot length, root length, seedling length, seedling dry weight, seedling vigour index-I, seedling vigour index-II and dehydrogenase enzyme activity when compared to other treatments and control followed by thiourea @ 0.5% at 1% level of significance and hence considered as the best dormancy alleviation treatment in cucumber seeds. Breaking the seed dormancy of various cucumber varieties benefit to the crop scientists and seed producing organizations to take up the seed production of various classes immediately after

harvest in order to meet the required quantity of high quality seeds of improved varieties and also it facilitates the farmers to raise the second crop. It also gives the message that seeds should be tested only after completion of dormancy. Even though it is not a problem in many areas, but it is almost required for farmers who take up crop production during late *rabi* season depending on availability of water. These farmers use seeds produced from immediate *kharif* harvested seeds. So the high value low volume seeds which fetches high cost can be easily overcome by this technique.

## References

1. Abdul Baki AA, Anderson JD. Vigour determination in soybean seeds by multiple criteria. *Crop Sci.* 1973; 13:630-633.
2. Abdul W, Habib A, Fida Abbasi M. Different treatment of rice seed dormancy breaking, germination of both wild

- species and cultivated varieties. *J Meteor. Environ. Sci.* 2012; 3:551-560.
3. Abdul W, Habib A, Fida Abbasi M. Different treatment of rice seed dormancy breaking, germination of both wild species and cultivated varieties. *J Meteor. Environ. Sci.* 2012; 3:551-560.
  4. Antonio RV, Maria Das, Antonio CF, Joao AO, Custodio DD. Action of gibberellic acid (GA<sub>3</sub>) on dormancy and activity of  $\alpha$ -amylase in rice seeds. *Rev. Bras. Sementes.* 2002; 24:43-48.
  5. Bewley JD. Seed germination and dormancy. *Plant Cell.* 1997; 9:1055-1066.
  6. Bijendra S, Poonam S, Singh CB, Sagar KS, Aunbhav K. Effect of growth regulators on seed germination, seedling growth, vigour and field emergence of freshly harvested seeds of linseed (*Linum usitatissimum* L.). *J Pharmacogn. Phytochem.* 2018; 7(2):3289-3292.
  7. Bosland PW, Votava EJ. Peppers: Vegetable and Spice Capsicums. *Crop Production Science in Horticulture*, 12. CAB International Publishing, Wallingford, England, UK, 2000, 204p.
  8. Brown R. An experimental study of the permeability to gases of the seed coat membrane of *Cucurbita Pepa*. *Ann. Bot.* 1940; 4:379-395.
  9. Bryant JA. *Seed physiology studies in biology*. Edward Arnold, London. No. 1985; 165:71.
  10. Cetinbas M, Koyuncu F. Improving germination of *Prunus avium* L. seeds by gibberellic acid, potassium nitrate and thiourea. *Hort. Sci.* 2006; 33(3):119-123.
  11. Farooq M, Basra SMA, Hafeez K. Seed invigoration by osmohardening in coarse and fine rice. *Seed Sci. Technol.* 2007; 34:181-187.
  12. Finkelstein RR, Reeves W, Ariizumi T, Steber CM. Molecular aspects of seed dormancy. *Annu. Rev. Plant Biol.* 2008; 59:387-415.
  13. Hendricks SB, Taylorson RB. Promotion of seed germination by nitrate, nitrite, hydroxylamine and ammonium salts. *Plant physiol.* 1974; 54:304-309.
  14. ISTA. *International Rules of Seed Testing*. *Seed Sci. Technol.* 2013; 27:25-30.
  15. Janaiah K, Kant K, Dadlani M. Efficacy of dormancy breaking methods in bittergourd (*Momordica charantia* L.). *Seed Res. J.* 2006; 34:45-49.
  16. Jaris BC, Frankland K, Band JH, Chery S. Increased nucleic acid synthesis in relation to the breaking of dormancy of hazel seed by gibberellic acid. *Plant Physiol.* 1968; 82:257-266.
  17. Kittock PA, Law AG. Relationship of seedling vigour to respiration and tetrazolium chloride reduction of germinating wheat seeds. *Agron. J* 1968; 60(4):286-288.
  18. Kota J, Kant K, Dadlani M. Efficacy of dormancy breaking methods in indica rice varieties. *Seed Res. J.* 2006; 34:45-49.
  19. Kucera B, Cohn MA, Leubnermetzger G. Plant hormone interactions during seed dormancy release and germination. *Seed Sci. Res.* 2005; 15:281-307.
  20. Kumar UM, Sastry KSK. Effect of exogenous application of growth regulators on germinating ability of developing sunflower seeds. *Indian J Experimental biolo.* 1974; 12(6):543-545.
  21. Lambat P, Charjan S, Deotale R, Gadewar R, Lambat A. Seed dormancy studies in cucumber (*Cucumis sativus* L.) cv. Shital. *Int. J Res. Biosci. Agric. Tech.* 2015; 2(7):370-371.
  22. Liela Y, Abbas Z, Saman S, Fardin K. Influence of high and low temperature treatments on seed germination and seedling vigour of rice (*Oryza sativa* L.). *World Applied Sci. J.* 2005; 16 (7):1015-1018.
  23. Longer DE, Degago Y. Field weathering potential of normal and hardseeded soybean genotypes. *Seed Sci. Technol.* 1996; 24:273-290.
  24. Mayer AM, Poljakoff M. *The germination of seeds*. 4<sup>th</sup> Edn. Pergamon Press. Londo. 1989, 270.
  25. Milosevic MM, Vujakovic D, Karagic. Vigour tests as indicators of seed viability. *Genetika.* 2010; 42(1):103-118.
  26. Miransari M, Smith D. Plant hormones and seed germination. *Environ. Exp. Bot.* 2014; 99:110-121.
  27. Mohamed-Yaseen Y, Barringer SA, Splittstoesser WE, Costanza S. The role of seed coats in seed viability. *Bot. Rev.* 1994; 60:426-439.
  28. Mohammad S, Sunder RS, Dutt KVLN. Effect of growth regulators on germinability of sunflower seeds. *Madrass Agri. Uni. J.* 1984; 69(8):557-558.
  29. Nawab A, Robert MS, Walter ES, David EH, William LG. Genetic factors and *in vitro* manipulations influence seed dormancy in cucumber. *Hortic. Sci.* 1991; 26(8):1076-1077.
  30. Plazek A, Dubert F, Kopec P, Dziurka M, Kalandyk A, Pastuszak J *et al.* Seed hydropriming and smoke water significantly improve low-temperature germination of *Lupinus angustifolius* L. *Int. J Mol. Sci.* 2018; 19:2-18.
  31. Randle WM, Homma H. Dormancy in peppers. *Sci. Hortic.* 1981; 14(1):19-25.
  32. Reddy NSB, Swamy PM. The effect of various growth regulators on germination of dormant ground nut seeds. *Indian J Plant Physiol.* 1976; 19(2):226-229.
  33. Sabongari S. Effect of soaking duration on germination and seedling establishment of selected varieties of tomato (*Lycopersicon esculentum* Mill). M.Sc. Thesis, Department of Biological Sciences, Usmanu Danfodiyo University, Sokoto, Nigeria, 2001.
  34. Shenoy VV, Seshu DV, Dadlani M. Association of laboratory assessed parameter with field emergence in rice. The non-anoic acid stress as a seed vigour test. *Seed Res.* 1990; 18(1):60-69.
  35. Singh PKD, Katiyar RP. Effect of certain growth regulators on germination and vigour paramaters in ground nut. *Seed Tech. News.* 1992; 22(1):2-3.
  36. Temiesagdie P, Takano T, Donsomprai P. Breaking the dormancy in cucumber (*Cucumis sativas* L.) seeds. *Kasetsart J Nat. Sci. Suppl.* 1991; 25:58-62.
  37. Tiwari N, Singh PLC, Katiyar PK, Vaish CP. Effect of pre-sowing seed treatment on germination, growth and yield of onion (*Allium cepa* L.). *Seed Res.* 2001; 29(2):238-239.
  38. Vanangamudi K, Anbukkarasi V, Prabhu M. Effect of seed treatments on germination and vigour parameters in kalmegh: Medicinal seeds and plants. *Annual medicinal plants.* 2014, 38-43.
  39. Vanden Born WH. Coriander seed dormancy germination and growth. *Can. J Plant Sci.* 1993; 51:53-59..