Acta Scientific AGRICULTURE (ISSN: 2581-365X)

Volume 5 Issue 3 March 2021

Research Article

# Effect of Different Chemicals on Eliminating the Dormancy Period of Freshly Harvested Seed Potatoes

**Muhammad Junaid Zaghum[1-3]*, Ali Zohaib[1,3], Muhammad Nouman Khalid[3], Ghulam Muhy Ud Deen[1], Armaghan Ahmad[1] and Syed Sajid Hussain Zaidi[4]**

*[1]Seed Science and Technology, Department of plant breeding and genetics, University of Agriculture, Faisalabad, Pakistan*

*[2]Seed physiology Laboratory, Department of Agronomy, University of Agriculture Faisalabad, Pakistan.*

*[3]Department of plant breeding and genetics, University of Agriculture, Faisalabad, Pakistan*

*[4]Plant Virology Section, Plant Pathology Research Institute, Ayub Agriculture Research Institute, Faisalabad, Pakistan*

***Corresponding Author:** Muhammad Junaid Zaghum, Department of plant breeding and genetics, University of Agriculture Faisalabad, Pakistan.

**Received:** December 26, 2020

**Published:** February 15, 2021



## Abstract

A study was conducted to investigate the response of freshly harvested seed potatoes treated with Sugar ($C_{12}H_{22}O_{11}$), Gibberellic Acid ($C_{19}H_{22}O_{6}$), Thiourea ($CH_4N_2S$), and Ethanol ($C_2H_5OH$) to find out which chemical treatment has more effectiveness for the elimination of dormancy period. Freshly harvested seed potatoes were collected from Plant Virology Section Research Area, Ayub Agricultural Research Institute, Faisalabad. *Solanum tuberosum* is a perennial because it is commercially propagated from tuber. In seed potato the normal dormancy period is 7-19 weeks. Results shows that treatment of 300g sugar powder in 600ml water eliminates the dormancy within 12-16 days at open light condition. Treatment with 600g sugar powder in 600ml water breaks the dormancy within 17-18 days at open light. Treatment with 300g sugar powder dry coating on wet surface of tuber eliminate the dormancy within 18-24 days at dark condition. Treatment with 1% TU and 1g $GA_3$ in 1000ml solution can eliminate the dormancy within 18 days at open light and dark conditions. 250ml solution of EtOH can eliminate the dormancy period within 24-26 days at open light and semi dark condition. The application of dormancy breaking chemicals such as sugar, gibberellic acid, thiourea and ethanol induces metabolic changes that lead to dormancy elimination and also from those occurring when dormancy is eliminate naturally. The present study exposed that under open light condition treatment of 300g sugar powder in 600ml water solution gave best results of tubers sprouting as compared to other treatments.

**Keywords:** *In vitro*; Perennial; Dormancy; Growth Regulators

## Abbreviations

S: Sugar; $GA_3$: Gibberellic Acid; TU: Thiourea; EtOH: Ethanol; C: Control.

## Introduction

Seed Potato is a primary storage organ of starch and one of the major human food sources [1]. It belongs to family Solanaceae.

Potato crop is ranking at 4th number of vegetable crops [2]. The potato family includes mainly herbaceous plant species and contains 70% water, 18% starch and 2% protein, whereas a 1% vitamin, mineral and trace element have been recorded [3]. Potatoes are rich in protein, calcium, vitamin C and have an especially good amino acid balance [4]. Potatoes are also a valuable source of nutrition in many developing countries, contributing carbohydrates, vitamins and minerals to the diet of millions [5]. In potato tubers, there are three phases of dormancy. The first phase of dormancy is called endodormancy where, even under ideal conditions, endogenous factors limit the development of sprouts. During the second stage of dormancy, the growth is restricted by external physiological factors, called paradormancy. The third stage of dormancy refers to ecodormancy during which external environmental factors interrupt meristematic development [6]. Tubers are endodormant immediately after harvest and do not produce sprout if kept at temperatures 3˚C [7]. Dormancy is known as a condition for survival. The life cycle of a potato tuber is characterized by the initiation and growth followed by a period of dormancy and finally sprouting resulting in the next generation [8]. The time of tuber initiation is until the breakdown of dormancy of potato tuber. As might be predicted from a developmental feature that gives a protective effect, the ancestry trend in tuber dormancy is complicated and regulated by nine different loci [9].

Endogenous hormones have been proposed to play a significant role in potato tuber bud dormancy regulation [10]. There are following methods that are used to eliminate seed dormancy. These methods are scarification, stratification, temperature treatment, light treatment and treatment with growth regulator i.e., gibberellic acid, thiourea, ethanol, cytokines, ethylene and other chemicals [11]. After the breakdown of dormancy, gibberellins help trigger bud activation, but the maintenance of dormancy may not be related to endogenous concentration [12].

Plant growth hormones have been suggested to play a prominent role in the control of tuberization [13]. Sprouting is one of the most physiological processes affecting postharvest tuber quality. This process is accompanied by other physiological and biochemical changes, including increases in respiration, water loss, reducing sugar content and glycoalkaloid content [14]. Potato tuber dormancy, which is considered to be a condition of physiological rest, is reported to start at the beginning of tuber initiation and continue until 6 to 12 weeks after harvest, depending on varietal characteristics [15].

Potato dormancy depends according to genotypes. It can also differ from a specified location or year in a tuber lot of one cultivar [16]. The genetic component, the tuber dormancy genetic basis, is complicated and many loci regulate it. The natural development of dormancy exists in many potato cultivars over a span of several months [6]. Typically, in early varieties, the dormancy period is shorter than in later cultivars, although this relationship is not very formal [17]. Furthermore, prolonged tuber dormancy is usually observed in populations of wild potatoes, while the alternative also exists in lines of potatoes produced through conventional breeding [18]. The duration of the dormancy cycle relied on the inherited history and influenced by the conditions pre- and post-harvest [19]. A variety of exogenous compounds that eliminate dormancy from field growing tubers, but specific micro-tuber assessments have been minimal. The dormancy duration and sprouting behavior are major criteria for the quality of a particular potato clone that should be recorded before any successful clone produced. Evident faint white buds distinguish the earliest detectable sprouting stage [17]. Whether it had some sprouts of 2 mm in length, a tuber considered sprouted, counted as peeping tuber with clear sprouts < 2 mm in length [20].

## Material and Methods

Freshly harvested seed potatoes are obtained from Plant Virology Section Research Area, Ayub Agricultural Research Institute Faisalabad. This experiment was conducted in the green house of Plant Virology Section, Ayub Agricultural Research Institute Faisalabad. *In vitro* take 180 freshly harvested seed potatoes. Use 30 seed potatoes for each treatment. Apply recommended dose of chemicals to freshly harvested seed potatoes according to treatment table. After treatment use dark envelop and muslin cloth to cover potatoes and place under three different conditions at 22-25°C. Daily observe it and start to take data on first number of potato sprout of any treatment. When 100% sprout complete stop to take data after the completion of sprouting the varieties of potato tubers were sown in earthen pots measuring 30 x 40cm containing garden soil and sand. The plants were watered on weekly basis.

### Table of treatments

| Treatments | No of Potatoes | Dose of Chemicals | | | Duration | Condition 22-25°C |
|---|---|---|---|---|---|---|
| Thiourea (TU) + Gibberellic acid ($GA_3$) | 30 | 1% solution + 1000ppm solution | | | Dipped for 1 hour in thiourea. After thiourea dipped for 15-20 minutes in gibberellic acid | Dark |
| | | Semi Dark | | | | |
| | | Open Light | | | | |
| Ethanol (EtOH) | 30 | 250ml solution | | | Dip for 30 seconds in Ethanol | Dark |
| | | Semi Dark | | | | |
| | | Open Light | | | | |
| Sugar (S) | 30 | T1 | Thick Solution of Sugar Powder | 400g in 600ml | Dip for 5-10 minutes in Thick Solution | Dark |
| | | | | | | Semi Dark |
| | | | | | | Open Light |
| | 30 | T2 | Spray of Sugar Powder | 300g in 600ml | Spray till 2-3 minutes | Dark |
| | | | | | | Semi Dark |
| | | | | | | Open Light |
| | 30 | T3 | Dry Coating of Sugar Powder on Wet Tuber Surface | 300g | Placement of Tubers in open light for 30 minutes after coating | Dark |
| | | | | | | Semi Dark |
| | | | | | | Open Light |
| Control (C) | 30 | Semi Dark | | | | Dark |
| | | Open Light | | | | |

**Table a**

## Results and Discussion

Results of different treatments in table form are given below.

Treatment with 1% thiourea and 1g gibberellic acid in 1000ml solution gave 70% sprout percentage at dark condition, 50% sprout

| Condition | Treatment | D-O-T | Tubers | 12D | 14D | 16D | 18D | 20D | 22D | 24D | S.P |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dark | Thiourea + Gibberellic Acid | 14/3/19 | 10 | 1 | 1 | 1 | 1 | 4 | 4 | 7 | 70% |
| Semi Dark | | 14/3/19 | 10 | 2 | 2 | 2 | 2 | 3 | 4 | 5 | 50% |
| Open light | | 14/3/19 | 10 | 2 | 3 | 3 | 4 | 4 | 6 | 6 | 60% |

**Table 1:** Result of Thiourea and Gibberellic acid Treatment.

percentage at Semi dark condition and 60% sprout percentage at open light condition within 12 days. The first number of sprout are start after 12 days of treatment.

Treatment with 250ml ethanol solution gave 60% sprout at dark condition, 60% sprout at Semi dark condition and 20% sprout at open light within 24 days. The first number of sprout treated with ethanol are start after 15 days at open light and 20 days at dark and semi dark condition.

| Condition | Treatment | D-O-T | Tubers | 12D | 14D | 16D | 18D | 20D | 22D | 24D | S.P |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dark | Ethanol | 14/3/19 | 10 | 0 | 0 | 0 | 0 | 2 | 3 | 6 | 60% |
| Semi Dark | | 14/3/19 | 10 | 0 | 0 | 0 | 0 | 2 | 4 | 6 | 60% |
| Open light | | 14/3/19 | 10 | 0 | 0 | 1 | 1 | 2 | 2 | 2 | 20% |

**Table 2:** Result of Ethanol Treatment.

Sugar powder can be use by 3 different modes of replication. Sugar powder solution spray, sugar powder thick solution and sugar powder solution spray and dry coating. Treatment with 300g sugar powder in 600ml water solution gave 50% sprout percentage at dark condition, 50% at semi dark condition and 100% at open light within 12-16 days. The sprouts are started after 6 days of treatment. Treatment with 400g sugar powder in 600ml water as thick solution gave 20% sprout at dark condition, 30% sprout at semi dark condition and 60% sprout at open light with in 24days. The sprouts are started after 8 days of treatment. Treatment with 300g sugar powder in 600ml water and 300g dry coating gave 60% sprout percentage at dark condition, 50% sprout percentage at semi dark condition and 40% sprout percentage at open light condition. The first number of sprouts are start after 14 days of treatment.

| Condition | Treatment | D-O-T | Tubers | 12D | 14D | 16D | 18D | 20D | 22D | 24D | S.P |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dark | Spray | 15/3/19 | 10 | 0 | 2 | 2 | 2 | 4 | 4 | 5 | 50% |
| | Thick Sol. | 15/3/19 | 10 | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 20% |
| | Spray + D.C. | 15/3/19 | 10 | 0 | 1 | 1 | 1 | 3 | 6 | 6 | 60% |
| Semi Dark | Spray | 18/3/19 | 10 | 2 | 2 | 2 | 3 | 3 | 5 | 5 | 50% |
| | Thick Sol. | 18/3/19 | 10 | 0 | 0 | 1 | 1 | 3 | 3 | 3 | 30% |
| | Spray + D.C. | 18/3/19 | 10 | 0 | 0 | 0 | 0 | 3 | 4 | 4 | 40% |
| Open light | Spray | 18/3/19 | 10 | 4 | 7 | 7 | 7 | 7 | 7 | 10 | 100% |
| | Thick Sol. | 18/3/19 | 10 | 2 | 4 | 4 | 4 | 4 | 6 | 6 | 60% |
| | Spray + D.C. | 18/3/19 | 10 | 0 | 2 | 2 | 2 | 3 | 3 | 4 | 40% |

**Table 3:** Result of Sugar Powder Treatment.

| Condition | Treatment | D-O-T | Tubers | 12D | 14D | 16D | 18D | 20D | 22D | 24D | S.P |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dark | Control | 14/3/19 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0% |
| Semi Dark | | 14/3/19 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0% |
| Open light | | 14/3/19 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0% |

**Table 4:** Result of Control Treatment.

Treatment with control gave 0% sprout percentage at dark, semidark and open light condition.

## Graphs of sprout percentage

Graph indicate the different treatment results at different conditions. Best results are given by.

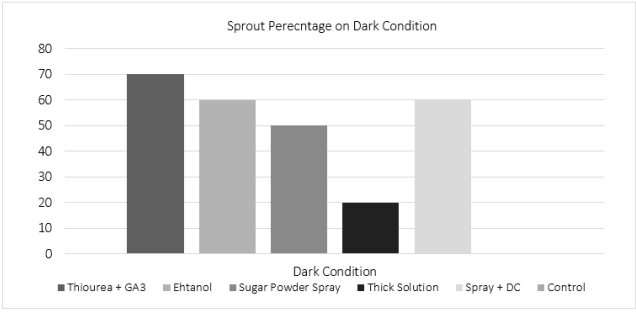


**Figure 1**

At dark condition the number of percentage of sprout of treatement with 1g gibberellic acid and 1% thiourea in 1000ml solution is 70%, 250ml ethanol solution is 60%, 300g sugar powder and 600ml water is 50%, 400g sugar powder and 600ml water as a thick solution is 20% and 300g sugar powder solution and 300g dry coating is 60%. The control treatment is 0% until the treatment ends.

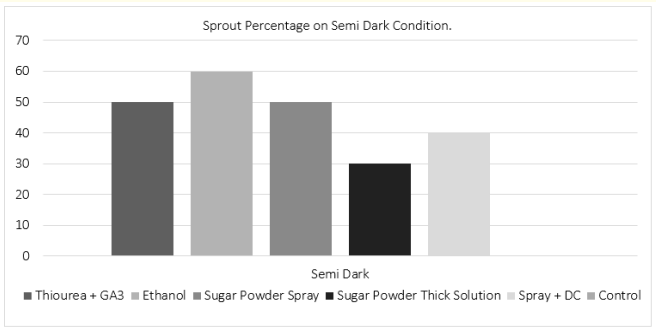


**Figure 2**

At semi dark condition the number of percentage of sprout of treatement with 1g gibberellic acid and 1% thiourea in 1000ml solution is 50%, 250ml ethanol solution is 60%, 300g sugar powder and 600ml water is 50%, 400g sugar powder and 600ml water as a thick solution is 30% and 300g sugar powder solution and 300g dry coating is 40%. The control treatment is 0% until the treatment ends.

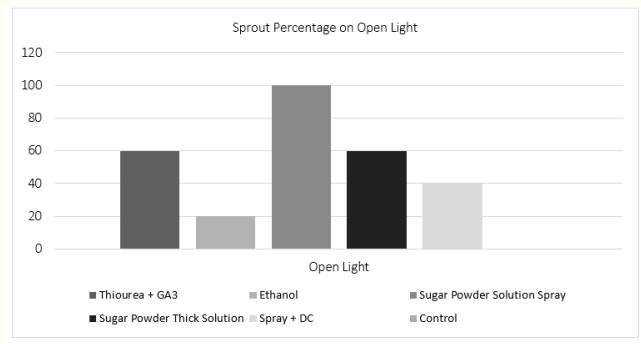


**Figure 3**

At open light the number of percentage of sprout of treatement with 1g gibberellic acid and 1% thiourea in 1000ml solution is 60%, 250ml ethanol solution is 20%, 300g sugar powder and 600ml water is 100%, 400g sugar powder and 600ml water as a thick solution is 60% and 300g sugar powder solution and 300g dry coating is 40%. The control treatment is 0% until the treatment ends.

## Conclusion

It is concluded that in vitro 30 seed potatoes treated with 300g sugar powder in 600ml water in open light condition at 25°C gave good results with in minimum number of days as comparison with gibberellic acid, thiourea and ethanol. In Pots it also gave good germination response and also improve vigor. It is cheap chemical and easily available and applicable by the farmer's community and potato growers for potato crop production.

## Authors Contribution

Conceived and design the experiment by Syed Sajid Hussain Zaidi and Muhammad Junaid Zaghum. Perform the experiment, record the data and wrote the paper by Ali Zohaib and Muhammad Junaid Zaghum.

## Bibliography

1. Mitchell M., *et al*. "Oil Accumulation in Transgenic Potato Tubers Alters Starch Quality and Nutritional Profile". *Frontiers in Plant Science* 8 (2017): 1-11.

2. Birch PRJ., *et al*. "Crops That Feed the World 8: Potato: Are the Trends of Increased Global Production Sustainable?" *Food Security* 4.4 (2012): 477-508.

3. Abbas A., *et al*. "Plant Viruses in Gilgit-Baltistan (GB) Pakistan: Potential Future Research Direction". *Journal of Plant Pathology and Microbiology* 10.486 (2020): 1-8.

4. Hotz C., *et al*. "Introduction of β-Carotene-Rich Orange Sweet Potato in Rural Uganda Resulted in Increased Vitamin an Intakes among Children and Women and Improved Vitamin a Status among Children". *Journal of Nutrition* 142.10 (2012): 1871-1880.

5. Camire ME., *et al*. "Potatoes and Human Health". *Critical Reviews in Food Science and Nutrition* 49.10 (2009): 823-840.

6. Campbell, M., *et al*. "Dormancy in Potato Tuber Meristems: Chemically Induced Cessation in Dormancy Matches the Natural Process Based on Transcript Profiles". *Functional and Integrative Genomics* 8.4 (2008): 317-328.

7. Suttle JC. "Dormancy and sprouting, In: Potato Biology and Biotechnology: Advances and Perspectives". *Elsevier, Amsterdam* (2007): 288-309.

8. Viola R., *et al*. "Symplastic Connection is Required for Bud Outgrowth Following Dormancy in Potato (*Solanum Tuberosum* L.) Tubers". *Plant, Cell and Environment* 30.8 (2007): 973-83.

9. Suttle JC. "Physiological regulation of potato tuber dormancy". *American Journal of Potato* 81 (2004): 253-262.

10. Graeber K., *et al*. "Molecular Mechanisms of Seed Dormancy". *Plant, Cell and Environment* 35 (2012): 1769-1786.

11. Hassani F., *et al*. "Effects of Chemical Treatments on Dormancy Breaking and Some Sprouting Characteristics of Two Potato Cultivars in Different Tuber Sizes". *European Journal of Experimental Biology* 4 (2014): 98-102.

12. Suttle JC. "Involvement of endogenous gibberellins in potato tuber dormancy and early sprout growth: a critical assessment". *Journal of Plant Physiology*161 (2004): 157-164.

13. Christensen CT., *et al*. "Comparative Evaluation of the Effects of Gibberellic Acid Concentrations on Dormancy Break in Tubers of Solanum Chacoense". *Horticulture Technology* 30 (2019): 76-81.

14. Zommick DH., *et al*. "In-Season Heat Stress Compromises Postharvest Quality and Low-Temperature Sweetening Resistance in Potato (*Solanum Tuberosum* L.)". *Planta* 239 (2014): 1243-1263.

15. Sonnewald S and Uwe S. "Regulation of Potato Tuber Sprouting". *Planta* 239 (2014): 27-38.

16. Liu B., *et al*. "Transcriptomic Changes during Tuber Dormancy Release Process Revealed by RNA Sequencing in Potato". *Journal of Biotechnology* 198 (2015): 17-30.

17. Aksenova NP., *et al*. "Regulation of Potato Tuber Dormancy and Sprouting". *Russian Journal of Plant Physiology* 60.3 (2013): 301-312.

18. Slater AT., *et al*. "Improving Breeding Efficiency in Potato Using Molecular and Quantitative Genetics". *Theoretical and Applied Genetics* 127.11 (2014): 2279-2292.

19. Muthoni J., *et al*. "Tetrasomic Inheritance in Cultivated Potato and Implications in Conventional Breeding". *Australian Journal of Crop Science* 9.3 (2015): 185-190.

20. Blauer JM., *et al*. "Evidence That Tuber Respiration Is the Pacemaker of Physiological Aging in Seed Potatoes (*Solanum Tuberosum* L.)". *Journal of Plant Growth Regulation* 32.4 (2013): 708-720.