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Studies on Seed Dormancy Breaking in Cucumber (*Cucumis sativus* L.) Variety Poinsett

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Experiments were carried out to study the effect of chemicals in breaking the dormancy of cucumber. The study was conducted at the Department of Vegetable Science, Horticultural College and Research Institute, Coimbatore during 2017-2018. The seeds of cucumber variety Poinsett were treated with various chemicals immediately after harvest to standardize the best dormancy breaking treatment. The design of the experiment was Factorial Randomised Block Design with two replications. The seeds were treated with the chemicals for 12 hrs and 24 hours duration. The germination test was conducted. Observations on seed and seedling quality parameters *viz*., speed of germination, and germination percent, vigor index I and vigor index II were recorded. At 12 hours duration, the highest speed of germination (23.29) was recorded in T_2 ($GA_3$150 ppm) whereas the highest germination percentage (92) was recorded in T_8 (Ethrel150 ppm). At 24 hours duration, the highest speed of germination (30.77) and the highest germination percentage (86) was observed in T_{12} ($KNO_3$500 ppm). At 12 hours duration, the highest Vigor Index I (2800.16) was recorded in T_9 (Ethrel 500 ppm) while the vigor Index II was the highest (12.19) in T_8 (Ethrel150 ppm). At 24 hours duration, the highest Vigor Index I (2349.28) was observed in T_{10} (Ethrel 1000 ppm) while the vigor Index II was the highest (14.066) in T_{11} ($KNO_3$150 ppm).

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1. INTRODUCTION

Freshly harvested seeds undergo a period of dormancy until a proper environment for germination occurs. A freshly harvested viable seed that cannot germinate under favorable conditions is called Primary dormancy [1]. If the seeds are to be sown immediately after harvest, dormancy breaking is imperative. Various methods are being employed in several crops for breaking seed dormancy such as warm stratification, chilling (cold stratification), light, or hormones (including gibberellins) [2,3]. Sometimes the seeds may enter secondary dormancy to avoid unfavorable conditions such as season changes [4]. Seed dormancy in cucumber is a varietal characteristic. Dormancy in cucumber is a temporary phase before completion of maturation process and hence it requires a ripening period for complete development of embryo inorder to achieve maximum germination after the harvest of the crop. As cucumber is grown throughout the year in different regions of the country, it is pertinent to determine the duration of dormancy. This information will be useful for efficient planning of production to ensure the timely availability of readily germinable seeds.

Dormancy may be caused by the formation of inhibitory compounds in the seeds, lack of growth-stimulating substances that are important, or caused by a hard seed coat so that water and oxygen cannot get in. Dormancy can be solved with a strong acid solution such as sulfuric acid and nitric acid. This solution makes the seed coat soften so that it can be easily traversed by water. Other chemicals that are also often used are potassium nitrate and thiourea. Thiourea acts on seed coat and increase cytokinin activity to overcome inhibition that leads to stimulation of seed germination [5]. Thiourea acts as a light substitute to enhance the germination. In addition, plant growth hormones such as cytokinins, gibberellins, auxin (e.g. Indole Acetic Acid), melatonin, and trytophan [6,1,7] may also be used to break seed dormancy. The present investigation was undertaken to devise an easy and economical method to overcome seed dormancy existing in cucumber.

2. MATERIALS AND METHODS

The study was conducted at the Department of Vegetable Science, Horticultural College and Research Institute, Coimbatore during 2017-2018. The design of the experiment was Factorial Randomised Block Design with two replications. The seeds of cucumber variety Poinsett were treated with various chemicals immediately after harvest to standardize the best dormancy breaking treatment. The seeds were treated with the chemicals at 12 hrs and 24 hours duration. A germination test was conducted in the seed testing laboratory of the Department of Seed Science and Technology. TNAU, Coimbatore.

2.1 Treatments

1. Soaking of seeds in water
2. Soaking of seeds in GA3 - 150 ppm, 500 ppm, 1000 ppm
3. Soaking of seeds in Cytokinin – 150 ppm, 500 ppm, 1000 ppm
4. Soaking of seeds in Ethrel – 150 ppm, 500 ppm, 1000 ppm
5. Soaking of seeds in KNO_3 – 150 ppm, 500 ppm
6. Soaking of seeds in HNO_3 – 150 ppm, 500 ppm

2.2 Soaking Duration

12 and 24 hours.

Observations on seed and seedling quality parameters *viz*., speed of germination, ~~and~~ germination percent,vigour index I and vigour index II were recorded.

2.3 Speed of Germination

Seeds were observed daily for seed germination (radicle emergence). Speed of germination was calculated by the following formula

Speed of germination= n1/d1+n2/d2+n3/d3+----------

Where, n = number of germinated seeds, d= number of days.

2.4 Germination Percentage

Germination percentageis an estimate of the viability of a population of seeds. The germination rate provides a measure of the time course of seed germination. The equation to calculate germination percentage is:

Germination percentage = seeds germinated / total seeds x 100

2.5 Seedling Length (cm)

The seedling length was measured from the collar region to the tip of the primary leaf. The mean seedling length was expressed in centimeters.

2.6 Seedling Dry Weight (mg)

The selected seedlings were kept in butter paper and dried in hot air oven at 80 ± 1^0C temperature for 24 hours. Then seedlings were removed from oven and allowed to cool before weighing on an electronic balance. The average weight of dried seedlings from each replication was calculated and expressed as dry weight of seedling in milligrams.

2.7 Seedling Vigor Indices

Seedling vigor indices were calculated by using the below formula [8] and expressed in whole number.

Vigor Index I = Germination (%) x Seedling length (cm)
Vigor Index II = Germination (%) x seedling dry weight (mg)

2.8 Statistical Analysis

The mean value of observations recorded on different seed parameters was subjected to statistical analysis. The analysis of variance for seed parameters were done [9].

3. RESULTS AND DISCUSSION

Observations on seed quality parameters *viz*., Speed of germination, and germination percent,vigor Index I and vigor index II were recorded. The treatments exhibited significant differences for the different seed quality parameters recorded. The effect of different treatments on the speed of germination and germination percent is given in Table 1.

Among the different treatments, the highest speed of germination (23.29) was recorded in T_2 ($GA_3$150 ppm) at 12 hours, while the lowest (7.71) was recorded at T_7 (Cytokinin 1000 ppm). Under 24 hours of soaking, the highest speed of germination (30.77) was observed in T_{12} ($KNO_3$500 ppm). Similarly, the lowest speed of germination (14.02) was registered in T_7 (Cytokinin 1000 ppm).

The germination percentage was the highest (92%) in T_8 (Ethrel150 ppm) at 12 hours duration, while a lower germination percentage of 40% was observed in T_6 (Cytokinin 500 ppm) and T_7 (Cytokinin 1000 ppm) at 12 hours. Under 24 hours soaking, the highest germination percentage of 86% was recorded in T_4 ($GA_3$1000 ppm), T_{10} (Ethrel 1000 ppm), and T_{12}($KNO_3$500 ppm) while the lowest (42%) was observed in T_6 (Cytokinin 500 ppm) and T_7 (Cytokinin 1000 ppm).

Table 1. Effect of dormancy breaking treatments on seed quality parameters in cucumber

Treatments	Speed of germination		Germination (%)	
	Duration of soaking			
	12 h	24 h	12h	24 h
T_1 (soaking in water)	22.05	24.83	88	84
T_2 ($GA_3$150 ppm)	23.29	24.07	84	80
T_3 ($GA_3$500 ppm)	19.41	22.49	76	72
T_4 ($GA_3$1000 ppm)	21.43	23.03	74	86
T_5 (Cytokinin150 ppm)	18.88	21.40	64	42
T_6 (Cytokinin 500 ppm)	8.37	19.19	40	42
T_7 (Cytokinin 1000 ppm)	7.71	14.02	40	42
T_8(Ethrel150 ppm)	20.39	24.51	92	72
T_9 (Ethrel 500 ppm)	18.80	25.90	88	80
T_{10} (Ethrel 1000 ppm)	18.59	25.04	78	86
T_{11} ($KNO_3$150 ppm)	18.11	28.37	86	84
T_{12}($KNO_3$500 ppm)	21.55	30.77	84	86
T_{13}($HNO_3$150 ppm)	20.23	28.62	86	74
T_{14} ($HNO_3$500 ppm)	17.93	29.39	78	76
Control	11.60	14.06	74	80
CD (0.05)	0.64	0.53	0.73	1.19

Table 2. Effect of seed coating treatments on seed vigor in cucumber

Treatments	Vigour Index I		Vigour Index II	
	Duration of soaking			
	12 h	24 h	12h	24 h
T_1 (soaking in water)	2470.36	2325.20	10.25	10.35
T_2 ($GA_3$150 ppm)	2470.16	2067.20	9.46	8.60
T_3 ($GA_3$500 ppm)	2342.00	1857.60	9.11	8.50
T_4 ($GA_3$1000 ppm)	2313.80	2268.04	8.16	11.59
T_5 (Cytokinin150 ppm)	597.44	224.28	6.37	4.68
T_6 (Cytokinin 500 ppm)	203.96	170.44	4.49	4.37
T_7 (Cytokinin 1000 ppm)	129.60	151.28	4.10	4.21
T_8(Ethrel150 ppm)	2746.56	1990.24	12.19	8.39
T_9 (Ethrel 500 ppm)	2800.16	2098.44	10.96	9.30
T_{10} (Ethrel 1000 ppm)	2400.24	2349.28	8.93	10.17
T_{11} ($KNO_3$150 ppm)	2627.32	2335.00	10.02	14.07
T_{12}($KNO_3$500 ppm)	2538.48	2344.96	9.32	10.67
T_{13}($HNO_3$150 ppm)	2435.36	2004.72	9.70	8.43
T_{14} ($HNO_3$500 ppm)	2215.16	2042.32	10.80	9.55
Control	2374.80	2092.80	9.73	9.19
CD (0.05)	4.46	191.76	2.42	0.55
CV%	4.82	160.19	35.60	8.79

At 12 hours duration, the highest Vigor Index I (2800.16) was recorded in T_9 (Ethrel 500 ppm) while the vigor Index II was the highest (12.19) in T_8 (Ethrel150 ppm).The lowest Vigor Index I (129.60) and Vigor Index II (4.10) was recorded in T_7 (Cytokinin 1000 ppm).

At 24 hours duration, the highest Vigor Index I (2349.28) was observed in T_{10} (Ethrel 1000 ppm) while the vigor Index II was the highest (14.066) in T_{11} ($KNO_3$150 ppm). The lowest Vigor Index I (151.28) and Vigor Index II (4.21) was recorded in T_7 (Cytokinin 1000 ppm).

The process of seed germination is a complex series of changes in morphology, physiology, and biochemistry. The first stage of seed germination begins with the absorption of water by seeds, seed coat softening, and hydration of protoplasm. The second phase begins with the activities of cells and enzymes as well as a rise in seed respiration. The third stage is the stage in which the degradation of materials such as carbohydrates, fats, and proteins into soluble forms happens and istaken to the growing points. The fourth stage is the assimilation of the materials that have been parted earlier in the meristematic area, to generate energy for the component formation activity and the growth of new cells. The fifth stage is the formation of sprouts through the process of division, enlargement of the growing point, and differentiation. While the leaves have not been able to function as photosynthetic organs, the seedling growth is highly dependent on the food supply in the seed.

Gibberellic acid is an important organic compound in the process of seed germination. In addition to stimulating the formation of amylase, gibberellins also stimulate the synthesis of ribonuclease, protease, cellulase, and peroxidase [10]. Gibberellins cause the activation of amylase and other enzymes. The activeness of amylase will lead to an overhaul of amylase and amylopectin thus allowing the translocation of substances from the storage area to the growing points, as a result, the seed which at first is dormant can germinate. If there was no gibberellin or it was less active, amylase will not be formed which can lead to the obstruction of the amylose and amylopectin reform process, which can result in the absence of germination or dormancy. In cucumber seeds, the gibberellic acid may be absent or less active. In the absence of gibberellin, the synthesis of the amylase, protease, cellulase, peroxidase, and ribonuclease enzymes does not happen. The non-formation of amylase obstructs the amylose reform process into glucose and maltose as well amylopectin cannot be converted into glucose, maltose, and dextrin limit. When protease is not formed, the protein cannot be converted into amino acids and amides. This means that in the absence of gibberellins, the breaking of stored food in the tissue cannot take place, so it cannot be translocated to the growth area because the stored food in the form of amylose, protein, and

fat cannot be transported from one cell to another cell, but must be reformed first into glucose and amide. Compounds in the form of glucose and amides (glutamine and asparagine) can be translocated to new growth areas. So with no gibberellin, the breaking of storage food will be obstructed, the translocation of nutrients from storage areas to the growth regions cannot take place so that the process of division, elongation, and differentiation of cells does not occur thus germination do not occur. The presence of gibberellins will stimulate the formation of amylase, protease, and other enzymes. The formation of amylase allows the decomposition of amylose into glucose and maltose, while amylopectin will break down into glucose, maltose, dextrin limit, etc. The formation of protease allows the decomposition of proteins into amino acids and amides. So it is clear that the presence of gibberellins allows the translocation of glucose and amides from the storage area to the growth area, cell division, and cell enlargement, and the next it will be a process of cell differentiation. Consequently, cucumber seeds that had been dormant were able to germinate. The results show that there are significant differences in the germination power of cucumber seed which is treated with gibberellic acid.

Seeds treated with thiourea @ 1 per cent recorded highest per cent of abnormal seedlings (11%) followed by seeds treated with thiourea @ 0.5 per cent (5.50%) [11]. The increased percent of abnormal seedlings in thiourea treated seeds was 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 [12,13]. These findings were in confirmity with [14] in Kalmegh.

Significantly highest per cent of fresh un-germinated seeds (64.50) were noticed in control followed by seeds treated with KNO3 at 0.4 per cent (58.75%) [11]. Some chemicals and growth regulators like KNO3, GA3, 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 [15,16,17,18,19].

The dehydrogenase enzyme activity was the highest (0.051) in seeds exposed to a hot dry air treatment at 70℃ for three days followed by thiourea at 0.5 per cent (0.049) and sun drying for 48 h (0.048) when compared with control (0.015) [11]. The dehydrogenase enzyme activity is an important indicator of breaking dormancy in seeds and also an efficient indicator of the degree of dormancy [6]. It is postulated that release from dormancy is associated with an increased activity of pentose phosphate pathway (PPP) dehydrogenases [20] as catalases and PPP activity is more during germination due to increased respiration, hydrolysis of stored food materials and energy synthesis.

4. CONCLUSION

In this experiment, the results showed that at 12 hours soaking, higher germination percentage, vigor index I, and vigour index II of cucumber seeds could be achieved when seeds were treated with ethrel. At 24 hours soaking the speed of germination, germination percentage, vigor index I, and vigor index II were higher in the treatment of seeds with KNO_3. A lower speed of germination, germination percentage, vigor index I, and vigor index II were observed when the seeds were treated with Cytokinin both under 12 and 24 hours duration.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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