J. Hortic. Sci.
Vol. 20(1), 2025

https://doi.org/10.24154/jhs.v20i1.2548

Original Research Paper

Seed dormancy in cucumber (*Cucumis sativus* L.): Insights and interventions

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ABSTRACT

Cucumber seeds that have been freshly extracted show dormancy. In the first experiment, cucumber var. Pusa Uday seeds were subjected to various treatments *viz*., running with tap water, GA_3, benzyl adenine, ethylene, KNO_3, HNO_3 and control (dry seed). The results revealed that seeds treated with benzyl adenine at 150 ppm for 12 hr recorded the highest germination (5.5%). Second experiment was carried out to find out an effective method for breaking seed dormancy and also to study how long it persists when stored under ambient conditions. When the initial trial with chemical treatments failed to break seed dormancy, the seeds were exposed to varying durations of dry heat treatment. Results revealed that seed dormancy in fresh seeds of the cucumber var. Pusa Uday could be totally overcome by a four-day dry heat treatment at 70°C without impacting other seed quality parameters. Such seeds could be stored for 24 months under ambient conditions without any reduction in viability and vigour. Additionally, it was observed that seed dormancy was naturally broken within 4 months when seeds were stored under ambient conditions, without any specific treatment.

Keywords: Cucumber, dormancy, seed germination, temperature, vigour index

INTRODUCTION

Cucumber, family Cucurbitaceae, is a monoecious vegetable crop that grows in the form of a sprawling vine with huge leaves and curling tendrils. Germination of fresh seeds of cucumber was hindered by primary dormancy (Jing et al., 2018). Dormancy is an attribute gained during evolution to survive adverse conditions such as heat, cold, drought, and salinity. Simpson (1965) defines seed dormancy as the failure of viable seed to germinate after a certain period of time in a set of environmental conditions, but later elicit germination when the restrictive state is removed. Primary dormancy is generally used to describe an intact, freshly harvested viable seed that cannot germinate in favorable conditions (Bewley, 1997). Dormancy is a serious problem with freshly extracted cucumber seeds; therefore, dormancy breaking is necessary if the seeds are planted immediately after harvest. According to Martins & Silva (2001), the seed dormancy in *Brachiaria brizantha* reduced at 70°C for 10 and 15 min and increased germination without adverse effects on physiological quality of seeds. Kavya et al. (2019) observed that exposure seeds to a hot dry air treatment at 70°C for 3 days to break dormancy in cucumber. In this study, chemicals which have hormonal/scarifying effects were tried to overcome dormancy in the beginning and when these chemicals were found ineffective, the seeds were subjected to dry heat treatment for various durations. The effect of dry heat treatment on seed quality during storage was also studied.

MATERIALS AND METHODS

The seed crop of cucumber cv. Pusa Uday variety was used for the present study. The laboratory experiment was carried out at the seed testing laboratory, ICAR-Indian Institute of Horticultural Research, Bengaluru, India. The fresh seeds with mucilage were kept for 1 day for fermentation and then the mucilage was removed by washing in water. The moisture content of freshly extracted seeds was brought down to 8% by drying first in shade and then by sun drying. Immediately after drying, the seeds were tested for germination as per ISTA (2013) rules to assess the degree of seed dormancy. Fresh seeds were found to have 100% dormancy. In the first experiment, the dormant seeds were subjected to the following chemical *viz*., leaching seeds in running tap water, GA_3 (150, 500 and 1000 ppm); benzyl adenine (150, 500 and 1000 ppm), ethylene (150, 500 and 1000 ppm), KNO_3 (150 and 500 ppm), HNO_3 (150 and 500 ppm)

and control (dry seed). The seeds were kept for 12 and 24 hr duration (Table 1).

Table 1 : Effect of seed treatments on seed germination of dormant seeds of cucumber cv. Pusa Uday

Treatment	Germination (%)	Abnormal seedlings (%)
Leaching for12 hr	1.5	0
Leaching for 24 hr	0	0
GA_3 150 ppm for12 hr	0	0
GA_3 500 ppm for 12 hr	0	1.5
GA_3 1000 ppm for 12 hr	0	0
GA_3 150 ppm for 24 hr	0	0
GA_3 500 ppm for 24 hr	1.5	0
GA_3 1000 ppm for 24 hr	0	0
Benzyl adenine 150 ppm for 12 h	0	5.5
Benzyl adenine 500 ppm for 12 hr	0	0
Benzyl adenine 1000 ppm for 12 hr	0	2.5
Benzyl adenine 150 ppm for 24 hr	0	1
Benzyl adenine 500 ppm for 24 hr	0	0
Benzyl adenine 1000 ppm for 24 hr	0	2.5
Ethrel 150 ppm for 12 hr	0	0
Ethrel 500 ppm for 12 hr	0	2.5
Ethrel 1000 ppm for 12 hr	0	0
Ethrel 150 ppm for 24 hr	0	1
Ethrel 500 ppm for 24 hr	0	0
Ethrel 1000 ppm for 24 hr	0	0
KNO_3 150 ppm for 12 hr	0	0
KNO_3 500 ppm for 12 hr	0	1
KNO_3 150 ppm for 24 hr	0	0
KNO_3 500 ppm for 24 hr	0	0
HNO_3 150 ppm for 12 hr	0	1
HNO_3 500 ppm for 12 hr	0	0
HNO_3 150 ppm for 24 hr	0	0
HNO_3 500 ppm for 24 hr	0	0
Distilled water for 12 hr	0	0
Distilled water for 24 hr	0	0
Control	0	0

In the second experiment, fresh seeds from second season crop after drying to 8% moisture as described above were subjected for hot air treatment at 70°C for various durations *viz.*, 3 to 11 days. The seeds packed in butter paper cover were placed in hot air oven set at 70°C±2°C. Seeds were removed from oven after the specified period and kept at humid chamber maintained at 25°C and 90% relative humidity for 1 day to bring the seeds back to 8-10% and then tested for seed quality.

In the third experiment, the dormant seeds were packed in cloth bag and stored at room temperature for monthly observation on seed germination. The treatments for third experiment were, T_1: heat treated seeds at 70°C for 7 days sealed in aluminum pouches stored in cold storage at 15°C, T_2: heat treated seeds at 70°C for 7 days sealed in aluminum pouches stored at ambient temperature, T_3: heat treated seeds at 70°C for 7 days without seal and stored at ambient temperature in butter paper cover, T_4: fresh seeds without treatment stored in butter paper at ambient temperature, T_5: fresh seeds without treatment stored in polythene cover at 10°C cold storage.

The standard germination test was carried out as per ISTA procedure by using germination paper method. Fifty seeds in four 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 per cent relative humidity. Then, the first and final count was taken on 4th and 8th day, respectively. The number of normal seedlings from each replication was counted and the mean germination was expressed in percentage as per ISTA (2013). Abnormal seedlings and dead seeds were counted separately and expressed in percentage.

$$\text{Seed germination (\%)} = \frac{\text{Number of normal seedlings} \times 100}{\text{Total number of seeds}}$$

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

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

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

High speed of germination is an indication of vigorous seed lot. Number of germinated seed counted every day from the first day and the cumulative index is made by the formula suggested by Maguire (1962).

Speed of germination = "(n/t)"

where, n is the number of seeds newly germinating at time t and t is days from sowing.

The data were analysed using ANOVA technique for completely randomized design and means were compared using least significant difference at 0.01 probability (Gomez & Gomez, 1984).

RESULTS AND DISCUSSION

The results of experiment involving various chemical treatments to break dormancy in fresh seeds of cucumber cv. Pusa Uday showed that none of the treatments was found effective in breaking seed dormancy. Among 31 treatments, leaching in running water for 12 hr and GA_3 500 ppm for 24 hr recorded only 1.5% germination. Seeds treated with benzyl adenine 150 ppm for 12 hr recorded the highest germination (5.5%), the resultant seedling were found abnormal (Table 1). Radomirka et al. (2006) reported that cytokinins stimulated the rate and percentage of seed germination at least two fold in Lotus corniculatus. In our preliminary study, we tried to germinate dormant cucumber seeds by removing seed coat and found a very little radical and cotyledons with greening, hence, benzyl adenine was used as one of the treatments as it is known to promote cell division particularly in meristems of roots and shoots, and in turn, plant growth.

In the second experiment, fresh dry seeds were exposed to dry heat of 70°C for 3 to 11 days. The results clearly indicated (Table 2) that dry heat treatment at 70°C increased the germination at all durations, whereas, the control had no germination. Exposure of seeds for 4 days resulted in maximum germination of 98%, which was on par with seeds exposed for 3-7 days. The seed quality was not affected till 7 days of exposure as reflected in speed of germination (45.4 days), vigour index I (3082) and II (404). Hence, exposure of dry seeds to 4 days at 70°C was found be ideal to break dormancy in fresh seeds of cucumber cv. Pusa Uday. Temiesagadie et al. (1991) and Kavya et al. (2019) also observed that exposure of cucumber seeds to a hot dry air treatment at 70°C for 3 days showed significantly higher germination and other seed quality attributes. Hot dry air treatment appeared to break the impermeability of nuclear membrane, promoting oxygen intake and imbibition of water thereby breaking dormancy (Temiesagadie et al., 1991). Intact inner integument was responsible for maintaining the dormancy in cucumber (Nawab et al., 1991). Dry 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 of short chain saturated fatty acids from the dormant seeds thereby increasing the germinability. Kota et al. (2006) and Abdul et al. (2012), also observed increase in germination of hulled rice seeds after heat treatment at 50°C in rice cultivars. Contrary

Table 2 : Effect of hot air treatment on germination and vigour of dormant seeds of cucumber cv. Pusa Uday

Treatment	First count (%)	Final germination (%)	Speed of germination	Abnormal seedlings	Dead seeds	Vigour Index I	Vigour Index II
3 days at 70°C	93.0 (74.2)	97.0 (80.0)	43.8	2.00	1.00	3019	416
4 days at 70°C	91.5 (73.3)	98.0 (81.8)	45.4	0.50	1.50	3082	404
5 days at 70°C	90.5 (72.1)	96.0 (78.4)	43.0	2.00	2.00	2976	403
6 days at 70°C	93.5 (84.0)	95.5 (77.7)	44.4	2.00	2.50	3046	395
7 days at 70°C	92.5 (76.5)	95.0 (77.0)	43.0	3.00	2.00	2553	391
8 days at 70°C	84.0 (66.4)	95.0 (77.0)	42.7	3.00	2.00	2727	384
9 days at 70°C	90.5 (72.1)	92.0 (73.5)	42.7	4.00	4.00	2627	369
10 days at 70°C	86.5 (68.5)	89.0 (70.6)	40.6	5.50	5.50	2490	363
11 days at 70°C	67.0 (54.9)	87.0 (68.8)	33.3	4.50	8.50	1916	350
Control	0.0	0.0	0.0	0.00	0.00	0	0
SEm±	1.5	1.7	0.6	0.69	0.93	29	8
C.D. at 1%	4.3	5.1	1.8	2.00	2.70	86	23
CV (%)	2.8	2.5	3.2	52.02	64.20	5	4.5

to this, Jing et al. (2018) reported that the primary dormancy in cucumber could be released by incubation at 5°C for 2-7 days.

In third experiment, seeds were exposed to dry heat treatment of 70°C for 7 days to know high temperature impact on viability and vigour during storage. Dry heat-treated seeds at 70°C for 7 days were taken for storage studies since the seed quality was not affected till 7 days of exposure as reflected in speed of germination, vigour index I and II in the previous experiment. The heat-treated seeds were packed in poly lined aluminum pouches and butter paper cover and stored at room temperature and cold storage, and seed quality was assessed at 4 months interval. Among the treatments, (Table 3) the highest germination (94%) was recorded in T_1 (heat treated seeds at 70°C for 7 days) packed in sealed aluminum pouches and stored in cold storage at 15°C even after 24 months of storage, while, lowest (90.5%) was recorded in T_4 (fresh seeds without treatment packed in butter paper cover and stored at ambient condition). However, all the treatments were on par with each other. Weerachet Jittanit et al. (2010) stated that drying temperature of 40°C was though safe for seed quality in corn, rice, and wheat seeds, drying at 60°C also resulted in more than 90% germination in wheat seeds in FBD. Similarly, Siddique & Wright (2003) reported that at 60°C drying pea seeds for up to 24 h did not result in a significant decrease in germination percentage. The dormancy in *Brachiaria brizantha* seeds if exposed to the temperature of 70°C for 10 and 15 min would be reduced and germination would be increased without adverse effects on physiological quality of seeds (Martins & Silva 2001).The present findings indicated that dry seeds could withstand exposure to higher temperature up to 70°C. However, the studies carried out by other researchers is confined to effect of high temperature on immediate seed quality but not studied its effect during storage. The present study demonstrated that dry cucumber seeds can be exposed to temperature as high as 70°C without affecting the seed quality for 2 years both under ambient and cold storage.

The low germination per cent (35.5%) in T_5 (fresh seeds without treatment stored at 10°C cold storage after 4 months of storage) was due to persistence of seed dormancy, whereas, fresh seeds stored at ambient temperature could overcome dormancy completely by 4th month resulting in 99% germination. These results are in conformity with the findings of Nasrul et al., (2023) who reported that decrease in ABA content during storage was significantly correlated to the increasing percentage of germination, maximum growth potential, seed vigour index and the decrease in seed dormancy intensity in cucumber seeds. Significant differences were observed between treated seeds and untreated seeds kept in cold storage with respect to vigour index I and II during 4-, 8- and 12-months storage (Table 4), mainly because of slow breakdown of dormancy in untreated seeds stored in cold storage, whereas, untreated fresh seeds stored at ambient temperature didn't differ with that of treated seeds.

Table 3 : Effect of storage temperature and duration on seed germination of cucumber cv. Pusa Uday

Treatment	Germination first count (%)						Germination final count (%)					
	Month						Month					
	4	8	12	16	20	24	4	8	12	16	20	24
T_1	91.00	74.00	100.00	81.50	88.50	79.50	99.00	100.00	100.00	98.00	96.00	94
T_2	89.00	68.00	98.50	80.50	89.50	73.50	98.00	97.00	99.70	95.50	94.50	92.5
T_3	85.00	77.50	97.00	84.50	85.00	72.00	98.00	97.00	97.80	93.00	93.50	92
T_4	90.00	73.00	82.50	79.50	88.50	71.00	99.00	94.00	91.70	94.00	93.00	90.5
T_5	22.50	69.00	98.50	81.50	85.50	77.00	35.50	97.50	98.50	94.50	93.00	91.5
CD at 1%	8.23	6.53	4.37				10.60	2.55	2.79			
CV (%)	5.04	4.18	2.12	NS	NS	NS	5.71	1.21	1.31	NS	NS	NS

T_1: heat treated seeds at 70°C for 7 days sealed in aluminum pouches stored in cold storage at 15°C; T_2: heat treated seeds at 70°C for 7 days sealed in Aluminum pouches stored at ambient temperature; T_3: heat treated seeds at 70°C for 7 days without seal and stored at ambient temperature in butter paper cover; T_4: fresh seeds without treatment stored in butter paper at ambient temperature and T_5: fresh seeds without treatment stored in polythene cover at 10°C cold storage

Table 4 : Effect of storage temperature and duration on Seed vigour index of cucumber cv. Pusa Uday

Treatment	Seed vigour index- I						Seed vigour index- II					
	Month						Month					
	4	8	12	16	20	24	4	8	12	16	20	24
T_1	3528.10	3462.50	3552.50	3331.35	3280.65	3299.70	8.04	8.13	8.60	8.35	7.84	7.59
T_2	3580.10	3368.80	3662.50	3232.45	3281.95	3244.50	8.14	7.76	7.83	8.33	8.05	7.17
T_3	3440.05	3424.55	3552.70	3155.20	3292.20	3215.35	8.01	7.70	7.77	7.81	7.59	7.25
T_4	3578.95	3293.80	3402.90	3228.65	3224.70	3208.55	7.85	7.15	7.30	8.18	7.79	7.35
T_5	1270.45	3354.05	3518.15	3209.90	2964.30	3138.75	2.89	7.61	7.78	7.54	7.53	7.14
CD at 1%	458.95	61.51	158.57	141.47	201.05		1.05			0.50	0.29	
CV (%)	6.89	0.84	2.07	2.04	2.90	NS	6.95	NS	NS	2.86	1.70	NS

T_1: heat treated seeds at 70°C for 7 days sealed in aluminum pouches stored in cold storage at 15°C; T_2: heat treated seeds at 70°C for 7 days sealed in Aluminum pouches stored at ambient temperature; T_3: heat treated seeds at 70°C for 7 days without seal and stored at ambient temperature in butter paper cover; T_4: fresh seeds without treatment stored in butter paper at ambient temperature and T_5: fresh seeds without treatment stored in polythene cover at 10°C cold storage

The germination percentage significantly increased every month until 12 months and then decreased, but not significantly until the end of the 24 month of storage period. From these results, it may be concluded that dry heat-treatment at 70°C for 4-7 days had no adverse impact on seed quality during storage, and fresh seeds can be subjected for dry heat treatment if the seed is required to be distributed to farmers immediately after extraction in order to get good field emergence. Even if such seeds are not sold, there is no risk of losing the viability of seeds in storage.

CONCLUSION

Subjecting the dry seeds of cucumber for hot air treatment at 70°C for 4 days could overcome seed dormancy in fresh seeds of cucumber variety Pusa Uday. The dormancy could also be overcome by storing the seeds under ambient temperature for 2-3 months. Heat-treated seeds could be stored in sealed aluminum pouches or butter paper cover for a period of 24 months under ambient conditions without affecting the seed quality.

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(Received : 12.2.2024; Revised : 15.4.2025; Accepted : 20.4.2025)