Effect of seed priming treatments on quality and storage life of cucumber cv K-75 seeds under temperature-stress conditions

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ABSTRACT

The present investigations were carried out in the Department of Vegetable Science, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during 2010 and 2011. The seeds of cucumber (*Cucumis sativus* L) cv K-75 were primed with nineteen treatments comprising osmo-priming (PEG 6000 -0.5 M Pa for 24 h, PEG 6000 -1.5 M Pa for 24 h, PEG 6000 -0.5 M Pa for 48 h and PEG 6000 -1.5 M Pa for 48 h), halo-priming (Na_2HPO_4 10^{-3} M for 24 h, Na_2HPO_4 10^{-1} M for 24 h, KH_2PO_4 10^{-3} M for 24 h, KH_2PO_4 10^{-1} M for 24 h, Na_2HPO_4 10^{-3} M for 48 h, Na_2HPO_4 10^{-1} M for 48 h, KH_2PO_4 10^{-3} M for 48 h and KH_2PO_4 10^{-1} M for 48 h), priming with growth regulator (GA_3 100 ppm for 24 h, GA_3 200 ppm for 24 h, GA_3 100 ppm for 48 h and GA_3 200 ppm for 48 h), hydro-priming (distilled water for 24 and 48 h) and a control (untreated). The seed storage study was carried out in the laboratory and the stored seeds were tested in a completely randomized design (CRD) with four replications. Seeds were primed with different primers at sub-optimal temperature (15°C) and stored for 3, 6, 9 and 12 months before testing for germination and vigour at 15°C in the germinator using towel paper. It was observed that seeds primed with PEG 6000 -1.5 M Pa for 24 h exhibited best results in terms of characters like speed of germination, per cent germination, seedling length and dry weight and vigour index-I and II when stored up to 6 months. However after 6 months of storage there was a sharp decline in germination and vigour of primed seeds. Priming of seeds with PEG 6000 -1.5 M Pa for 24 h may therefore be recommended to the growers and seed producers after on-farm testing in multi-location trials for better storage and higher yield in cucumber.

Keywords: Cucumber; priming; halo-priming; growth regulator; PEG-6000

INTRODUCTION

Cucumber (*Cucumis sativus* L) is one of the most important cucurbitaceous vegetable crops grown extensively in tropical and sub-tropical parts of the country and is believed to be originated in India (Bose and Som 1986). It is a thermophilic and frost-susceptible species which grows best at temperatures above 20°C. Optimum seed germination and seedling growth in cucumber takes place at 20-25°C (Wien 1996). High humidity and short day conditions promote female flower production (Rai and Yadav 2005). Mid-hills of Himachal Pradesh are the main supplier of quality cucumber fruits to the plains. In the hills cucumber is grown as a summer or rainy season crop. Maximum returns from this crop can be obtained if fruits get ready for the market early in the months of May and June as during this period cucumber cannot be grown in the plains due to high temperature. In order to get the fruits during May-June cucumber seeds need to be sown in the month of February or in the beginning of March. During this part of the year the temperature in the mid-hills is quite low resulting in poor seed germination.

Delayed and reduced germination and seedling emergence are major setbacks to achieve uniform and vigorous crop stand in early spring-planted cucumber (Nerson and Govers 1986). Hence due to slow seed germination in the month of February the subsequent crop production is also delayed and farmers do not catch up the markets in the north Indian plains during May-June.

Various studies have been carried out to reduce the time period between sowing and seedling emergence as well as to increase seed tolerance to adverse environmental conditions during the germination process. The problem of poor or slow seed germination can be solved through many techniques and one of them is seed priming. Seed priming is basically a pre-sowing controlled seed hydration treatment in which seeds are soaked in an osmotic solution or solid carrier with low matric potential that allows them to imbibe water and go through first stage of germination but does not permit radical protrusion through the seed coat. After priming the seeds are dried back to enable normal handling, storage and planting (Copeland and McDonald 1995).

Seed moisture content and storage temperature are considered as the main factors in maintaining viability. Although priming has been shown to improve the germination of seeds of many plant species its effects in relation to seed storage are still ill-defined.

Generally where primed seed is stored the period of storage has been short. Primed seed needs to be stored under controlled environment to maintain seed quality (Cabrera and Lansakara 1995). Keeping in view the above facts the present study was carried out using different osmotica, salts and growth regulator for priming cucumber seeds.

MATERIAL and METHODS

The present investigations were carried out at the experimental farm of the Department of Vegetable Science, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during 2010 and 2011. The seed storage study was carried out under ambient conditions in the laboratory.

In all there were nineteen treatments comprising osmopriming (PEG 6000 -0.5 M Pa for 24 h, PEG 6000 -1.5 M Pa for 24 h, PEG 6000 -0.5 M Pa for 48 h and PEG 6000 -1.5 M Pa for 48 h), halo-priming (Na_2HPO_4 10^{-3} M for 24 h, Na_2HPO_4 10^{-1} M for 24 h, KH_2PO_4 10^{-3} M for 24 h, KH_2PO_4 10^{-1} M for 24 h, Na_2HPO_4 10^{-3} M for 48 h, Na_2HPO_4 10^{-1} M for 48 h, KH_2PO_4 10^{-3} M for 48 h and KH_2PO_4 10^{-1} M for 48 h), priming with growth regulator (GA_3 100 ppm for 24 h, GA_3 200 ppm for 24 h, GA_3 100 ppm for 48 h and GA_3 200 ppm for 48 h), hydro-priming (distilled water for 24 and 48 h) and a control (untreated).

Seeds of cucumber cv K-75 were primed with different primers at 15°C and were stored for 3, 6, 9 and 12 months before testing for germination and vigour at 15°C in the germinator using towel paper. Storage experiment was conducted in completely randomized design with four replications. Two hundred seeds of each treatment were placed on the blotter paper and kept in the germinator for testing after every storage period. The observations were recorded on speed of germination, germination percentage (first and final count), seedling length, seedling dry weight, vigour index-I and vigour index-II.

RESULTS and DISCUSSION

Speed of germination

Maximum speed of germination over all the storage periods was recorded in T_2 (PEG 6000 -1.5 M Pa for 24 h) having values of 7.33, 6.84, 6.31, 4.95 and 3.28 after 1 week and 3, 6, 9 and 12 months of storage respectively (Table 1). This treatment was statistically at par with T_3, T_1, T_5 and T_4 and differed significantly from rest of the treatments. Minimum speed of germination was however recorded in T_{19} (Control) except 9 and 12 months of storage. Speed of germination in general decreased as storage period progressed.

The possible reason for fastest speed of germination of the seeds primed with PEG 6000 -1.5 M Pa for 24 h at 15°C may be the completion of pre-germinative metabolic activities enabling the seeds ready for radicle protrusion thus making conditions favorable for early and fast germination compared to untreated dry seeds (Arif 2005).

Germination percentage

The data given in Table 2 reveal that maximum seed germination after different storage periods (1 week and 3, 6 and 9 months) up to 9 months at first count was recorded in the treatment T_2 (PEG 6000 -1.5 M Pa for 24 h) with values 72.55, 66.41, 63.75 and 42.15 per cent respectively. However after 12 months of storage the highest value for seed germination (33.67%) was recorded in control. Up to 9 months of storage treatment T_2 was statistically superior over rest of the treatments except treatments T_3, T_5, T_{13}, T_{14}, T_{16} and T_{17} after 3 months of storage. Minimum germination during first count was recorded in different treatments after different storage periods as is evident from the data.

Table 1. Effect of seed priming on speed of germination of cucumber cv K-75 seed tested at 15°C temperature (data pooled over two years)

Treatment code	Treatment	Speed of germination (%) after				
		1 week	3 months	6 months	9 months	12 months
T_1	PEG6000 -0.5 M Pa 24 h	7.19	6.71	6.16	4.77	2.94
T_2	PEG6000 -1.5 M Pa 24 h	7.33	6.84	6.31	4.95	3.28
T_3	Na_2HPO_4 10^{-3} M 24 h	7.30	6.82	6.19	4.83	3.17
T_4	Na_2HPO_4 10^{-1} M 24 h	7.04	6.56	6.04	4.67	3.04
T_5	KH_2PO_4 10^{-3} M 24 h	7.18	6.70	6.16	4.77	2.99
T_6	KH_2PO_4 10^{-1}M 24 h	6.76	6.28	5.78	4.45	2.98
T_7	GA_3 100 ppm 24 h	5.46	4.98	4.46	3.09	2.54
T_8	GA_3 200 ppm 24 h	6.17	5.69	5.15	3.78	1.56
T_9	Distilled water 24 h	4.65	4.17	3.67	2.32	2.32
T_{10}	PEG6000 -0.5 M Pa 48 h	5.91	5.35	4.80	3.43	1.45
T_{11}	PEG6000 -1.5 M Pa 48 h	6.17	5.63	5.15	3.82	2.02
T_{12}	Na_2HPO_4 10^{-3} M 48 h	4.86	4.30	3.77	2.39	1.89
T_{13}	Na_2HPO_4 10^{-1} M 48 h	6.24	5.70	5.20	3.86	2.00
T_{14}	KH_2PO_4 10^{-3} M 48 h	6.28	5.73	5.21	3.85	2.19
T_{15}	KH_2PO_4 10^{-1} M 48 h	4.56	4.08	3.55	2.18	2.06
T_{16}	GA_3 100 ppm 48 h	6.64	6.16	5.62	4.24	1.75
T_{17}	GA_3 200 ppm 48 h	6.18	5.70	5.16	3.76	2.28
T_{18}	Distilled water 48 h	6.60	6.12	5.58	4.21	2.62
T_{19}	Untreated (Control)	3.97	3.18	2.98	2.77	2.45
	CD	0.42	0.42	0.42	0.42	0.43

Similarly maximum seed germination after different storage periods at final count was observed in treatment T_2 (PEG 6000 -1.5 M Pa for 24 h) having values of 83.05, 75.85, 74.35, and 47.95 per cent after 1 week and 3, 6 and 9 months of storage respectively however control treatment showed maximum germination (39.91%) after 12 months of storage. Minimum germination was recorded in T_{19} (Control) up to 6 months of storage.

Enhancement of seed germination due to priming with PEG 6000 -1.5 M Pa for 24 h may be due to leaching of some growth inhibitors that prevented germination initiating metabolic events of primed seeds (Heydecker and Coolbear 1978).

Seedling length

The pooled data (Table 3) show that maximum seedling length in all the storage periods was observed in treatment T_2 (PEG 6000 -1.5 M Pa for 24 h) with values 16.13, 15.29, 13.63, 11.99 and 10.35 respectively. Treatment T_2 was statistically at par with T_3 and T_1 over all the storage periods except 1 week after storage. Minimum seedling length was observed in T_{19} (Control) up to 6 months of storage and T_{15} recorded the minimum values for storage of 9 and 12 months.

The seeds treated with PEG 6000 -1.5 M Pa for 24 h resulted in more seedling length followed by those treated with Na_2HPO_4 10^{-3} M for 24 h. However control treatment recorded minimum seedling length during all the storage periods except in seeds stored for 9 and 12 months after priming.

It seems that more seedling length or growth of the seedlings was due to earlier germination of seeds following priming which provided the seedlings more time to grow. The present findings are in agreement with those of Nascimento and West (1999).

Seedling dry weight

Significant differences among various treatments for seedling dry weight and maximum seedling dry weight up to 9 months of storage periods (1.62, 1.56, 1.41 and 1.13 mg after 1 week and 3, 6 and 9 months of storage respectively) were observed in treatment T_2 (PEG 6000-1.5 M Pa for 24 h) except after 12 months of storage where the maxima was observed in treatment T_1. Treatment T_2 was statistically at par with many other treatments including T_3, T_5, T_1 and T_8 in all the storage periods. However minimum seedling dry weight was observed in treatment T_{16} for all the storage periods (Table 3).

Table 2. Effect of seed priming on germination of cucumber cv K-75 seed tested at 15°C temperature (data pooled over two years)

Treatment code	Treatment	1st count germination (%) after					Final count germination (%) after				
		1 week	3 months	6 months	9 months	12 months	1 week	3 months	6 months	9 months	12 months
T_1	PEG6000 -0.5 M Pa 24 h	69.23 (56.29)	65.35 (53.92)	60.43 (51.00)	37.23 (37.58)	21.77 (27.79)	79.58 (63.12)	73.12 (58.75)	69.38 (56.38)	45.38 (42.33)	25.42 (30.25)
T_2	PEG6000 -1.5 M Pa 24 h	72.55 (58.39)	66.41 (54.56)	63.75 (52.96)	42.15 (40.47)	26.69 (31.09)	83.05 (65.67)	75.85 (60.54)	74.35 (59.56)	47.95 (43.81)	30.69 (33.62)
T_3	Na_2HPO_4 10^{-3} M 24 h	69.67 (56.57)	66.15 (54.41)	60.07 (50.79)	38.47 (38.32)	23.27 (28.82)	81.75 (64.70)	74.79 (59.85)	69.15 (56.24)	45.45 (42.37)	28.75 (32.40)
T_4	Na_2HPO_4 10^{-1} M 24 h	68.01 (55.54)	61.35 (51.54)	52.81 (46.59)	26.41 (30.90)	12.15 (20.35)	77.29 (61.53)	72.53 (58.37)	61.99 (51.92)	38.59 (38.39)	21.23 (27.41)
T_5	KH_2PO_4 10^{-3} M 24 h	69.55 (56.49)	66.07 (54.35)	60.55 (51.07)	38.95 (38.60)	23.49 (28.97)	81.25 (64.32)	73.89 (59.25)	69.85 (56.68)	45.25 (42.26)	27.09 (31.35)
T_6	KH_2PO_4 10^{-1}M 24 h	64.47 (53.39)	59.36 (50.38)	53.27 (46.86)	26.87 (31.20)	12.21 (20.41)	76.83 (61.21)	68.47 (55.82)	60.63 (51.12)	36.33 (37.05)	17.17 (24.46)
T_7	GA_3 100 ppm 24 h	66.02 (54.33)	57.55 (49.33)	55.36 (48.06)	28.96 (32.54)	14.82 (22.60)	76.44 (60.95)	65.00 (53.71)	60.24 (50.89)	33.24 (35.05)	19.10 (25.89)
T_8	GA_3 200 ppm 24 h	66.61 (54.68)	61.73 (51.76)	57.55 (49.33)	34.35 (35.86)	20.21 (26.69)	75.75 (60.48)	68.81 (56.03)	64.05 (53.14)	37.95 (35.19)	21.11 (27.33)
T_9	Distilled water 24 h	67.33 (55.12)	61.80 (51.81)	55.33 (48.04)	32.13 (34.51)	18.53 (25.47)	74.58 (59.70)	69.98 (56.75)	62.88 (52.44)	36.48 (38.01)	20.78 (27.10)
T_{10}	PEG6000 -0.5 M Pa 48 h	66.06 (54.35)	57.31 (49.18)	56.46 (48.69)	33.26 (35.20)	19.66 (26.30)	75.14 (60.08)	66.04 (53.34)	64.34 (53.32)	36.74 (37.14)	21.94 (27.91)
T_{11}	PEG6000 -1.5 M Pa 48 h	66.11 (54.38)	63.57 (52.86)	53.31 (46.88)	26.91 (31.23)	13.31 (21.36)	76.79 (61.18)	71.59 (57.77)	61.49 (51.63)	34.49 (37.29)	19.99 (26.54)
T_{12}	Na_2HPO_4 10^{-3} M 48 h	66.23 (54.45)	61.85 (51.84)	57.17 (49.10)	32.37 (34.65)	18.23 (25.24)	76.23 (60.81)	68.69 (55.96)	64.53 (53.43)	33.93 (35.95)	18.89 (25.73)
T_{13}	Na_2HPO_4 10^{-1} M 48 h	67.19 (55.04)	63.78 (52.98)	57.05 (49.04)	32.25 (34.59)	18.39 (25.37)	78.05 (62.04)	72.29 (58.22)	65.45 (53.98)	36.65 (35.61)	20.09 (26.61)
T_{14}	KH_2PO_4 10^{-3} M 48 h	67.78 (55.40)	65.46 (53.99)	57.38 (49.23)	34.18 (35.76)	19.24 (25.99)	78.62 (62.44)	72.68 (58.47)	64.52 (53.42)	38.42 (37.24)	21.08 (27.31)
T_{15}	KH_2PO_4 10^{-1} M 48 h	67.86 (55.45)	63.03 (52.54)	59.06 (50.20)	34.26 (35.80)	19.06 (25.85)	75.04 (60.02)	68.84 (56.05)	64.54 (53.44)	37.24 (38.28)	19.64 (26.27)
T_{16}	GA_3 100 ppm 48 h	67.03 (54.94)	66.15 (54.41)	57.43 (49.26)	34.23 (35.79)	19.03 (25.84)	79.37 (62.97)	73.17 (58.78)	65.87 (54.23)	39.77 (39.08)	21.87 (27.86)
T_{17}	GA_3 200 ppm 48 h	69.38 (56.39)	65.00 (53.71)	58.98 (50.15)	32.58 (34.78)	17.64 (24.78)	76.03 (60.67)	70.99 (57.39)	63.73 (52.95)	37.33 (37.64)	19.69 (26.30)
T_{18}	Distilled water 48 h	63.14 (53.60)	58.73 (50.01)	49.80 (44.87)	20.20 (26.68)	12.56 (20.71)	74.60 (59.72)	67.76 (55.39)	61.10 (51.40)	35.00 (36.25)	21.86 (27.85)
T_{19}	Untreated (Control)	55.53 (48.16)	52.00 (46.13)	44.33 (41.73)	36.33 (37.05)	33.67 (35.45)	62.97 (52.20)	62.41 (52.16)	57.27 (49.16)	43.77 (41.40)	39.91 (39.16)
	CD	1.71	1.66	1.70	1.73	1.73	1.40	1.09	1.68	1.71	1.71

Figures in parentheses represent arc sin transformed values

Table 3. Effect of seed priming on seedling length and dry weight of cucumber cv K-75 seed tested at 15°C temperature (data pooled over two years)

Treatment Code	Treatment	Seedling length (cm) after					Dry weight (mg) after				
		1 week	3 months	6 months	9 months	12 months	1 week	3 months	6 months	9 months	12 months
T_1	PEG6000 -0.5 M Pa 24 h	15.28	14.75	13.09	11.49	9.81	1.47	1.51	1.40	1.07	0.91
T_2	PEG6000 -1.5 M Pa 24 h	16.13	15.29	13.63	11.99	10.35	1.62	1.56	1.41	1.13	0.80
T_3	Na_2HPO_4 10^{-3} M 24 h	15.74	15.14	13.48	11.84	10.16	1.58	1.55	1.39	1.13	0.88
T_4	Na_2HPO_4 10^{-1} M 24 h	14.96	13.98	12.30	10.66	9.02	1.32	1.25	1.13	0.91	0.66
T_5	KH_2PO_4 10^{-3} M 24 h	15.33	14.73	13.07	11.51	9.79	1.57	1.53	1.38	1.12	0.88
T_6	KH_2PO_4 10^{-1}M 24 h	14.97	14.00	12.27	10.63	9.02	1.26	1.19	1.09	0.82	0.58
T_7	GA_3 100 ppm 24 h	13.72	12.88	11.22	9.58	7.95	1.42	1.36	1.24	0.97	0.72
T_8	GA_3 200 ppm 24 h	14.27	13.79	12.27	10.49	8.86	1.54	1.46	1.37	1.09	0.86
T_9	Distilled water 24 h	14.62	13.94	12.45	10.64	9.01	1.35	1.28	1.18	0.91	0.67
T_{10}	PEG6000 -0.5 M Pa 48 h	14.05	13.33	11.99	10.03	8.40	1.35	1.28	1.19	0.90	0.66
T_{11}	PEG6000 -1.5 M Pa 48 h	14.15	13.51	12.18	10.21	8.57	1.40	1.33	1.22	0.93	0.69
T_{12}	Na_2HPO_4 10^{-3} M 48 h	13.22	12.62	11.28	9.32	7.69	1.39	1.32	1.20	0.93	0.68
T_{13}	Na_2HPO_4 10^{-1} M 48 h	13.94	13.24	11.84	9.94	8.31	1.35	1.28	1.21	0.93	0.69
T_{14}	KH_2PO_4 10^{-3} M 48 h	14.03	13.23	11.75	9.93	8.29	1.32	1.24	1.14	0.87	0.63
T_{15}	KH_2PO_4 10^{-1} M 48 h	13.17	12.47	11.07	9.17	7.54	1.35	1.28	1.16	0.91	0.66
T_{16}	GA_3 100 ppm 48 h	13.60	12.64	11.19	9.34	7.71	1.18	1.11	1.00	0.73	0.49
T_{17}	GA_3 200 ppm 48 h	13.15	12.67	11.02	9.37	7.74	1.47	1.40	1.32	1.03	0.79
T_{18}	Distilled water 48 h	13.58	12.86	11.28	9.56	7.91	1.36	1.29	1.17	0.90	0.66
T_{19}	Untreated (Control)	12.91	12.39	10.73	10.65	10.63	1.38	1.31	1.19	0.92	0.68
	CD	0.70	0.71	0.69	0.77	0.71	0.15	0.18	0.16	0.13	0.12

Table 4. Effect of seed priming on vigour index-I and vigour index-II of cucumber cv K-75 seed tested at 15°C temperature (data pooled over two years)

Treatment Code	Treatment	Vigour index-I after					Vigour index-II after				
		1 week	3 months	6 months	9 months	12 months	1 week	3 months	6 months	9 months	12 months
T_1	PEG6000 -0.5 M Pa 24 h	1216.32	1078.75	908.67	522.07	250.02	116.67	110.17	96.95	48.73	23.14
T_2	PEG6000 -1.5 M Pa 24 h	1339.76	1159.45	1013.70	575.47	318.21	134.66	117.98	104.52	53.98	24.64
T_3	Na_2HPO_4 10^{-3} M 24 h	1287.16	1132.90	932.73	538.94	293.08	129.29	116.15	96.28	51.49	25.43
T_4	Na_2HPO_4 10^{-1} M 24 h	1156.80	1014.40	763.19	412.28	192.42	102.00	90.63	70.06	35.09	13.99
T_5	KH_2PO_4 10^{-3} M 24 h	1245.73	1088.48	913.27	521.39	265.80	127.68	112.79	96.55	50.80	23.96
T_6	KH_2PO_4 10^{-1}M 24 h	1150.56	958.89	744.50	386.93	155.60	96.86	81.52	66.17	29.84	10.01
T_7	GA_3 100 ppm 24 h	1049.83	838.14	677.06	319.69	153.02	108.76	88.60	74.94	32.46	13.97
T_8	GA_3 200 ppm 24 h	1081.40	949.25	786.51	398.94	187.90	116.71	100.51	87.84	41.42	18.21
T_9	Distilled water 24 h	1090.65	975.71	783.30	388.77	187.83	100.79	89.68	74.34	33.31	14.04
T_{10}	PEG6000 -0.5 M Pa 48 h	1056.43	880.90	772.25	369.40	185.12	101.57	84.66	76.73	33.20	14.62
T_{11}	PEG6000 -1.5 M Pa 48 h	1086.85	967.35	749.39	352.80	171.97	107.62	95.32	75.17	32.19	13.91
T_{12}	Na_2HPO_4 10^{-3} M 48 h	1008.38	867.80	729.07	317.59	146.60	105.98	90.76	77.57	31.65	12.94
T_{13}	Na_2HPO_4 10^{-1} M 48 h	1087.79	957.21	775.29	364.91	167.57	105.41	92.64	79.35	34.21	13.99
T_{14}	KH_2PO_4 10^{-3} M 48 h	1103.14	961.96	758.77	382.33	175.54	103.86	90.27	73.74	33.59	13.44
T_{15}	KH_2PO_4 10^{-1} M 48 h	989.54	859.98	716.23	343.35	149.86	101.39	88.27	75.06	34.05	13.12
T_{16}	GA_3 100 ppm 48 h	1079.77	925.48	737.92	372.31	169.36	93.66	81.29	65.99	29.12	10.80
T_{17}	GA_3 200 ppm 48 h	1001.00	900.92	704.01	351.53	154.05	111.68	99.37	84.16	38.45	15.56
T_{18}	Distilled water 48 h	1013.70	872.31	690.36	335.86	174.10	101.53	87.56	71.68	31.66	14.58
T_{19}	Untreated (Control)	813.28	773.88	615.35	467.06	426.11	86.91	81.84	68.28	40.36	27.23
	CD	68.56	64.37	64.42	47.93	31.64	12.76	13.92	12.32	6.56	4.07

The seedling dry weight was more when tested at 15°C in PEG 6000 -0.5 M Pa for 24 h at 15°C except after twelve months of storage period. The present results have the support of Odell et al (1992) who while working on tomato also obtained higher shoot dry weight for primed seeds germinated at stressful temperature condition than for non-primed seeds.

Vigour index-I

Data given in Table 4 show that maximum vigour index-I up to 9 months of storage (1339.76, 1159.45, 1013.70 and 575.47 after 1 week and 3, 6 and 9 months respectively) was observed in T_2 (PEG 6000 -1.5 M Pa for 24 h) which was statistically at par with T_3 (Na_2HPO_4 10^{-3} M for 24 h) after 1 week and 3 and 9 months of storage periods. After 12 months of storage however maximum vigour index-I (426.11) recorded for control had significant difference with rest of the treatments. Minimum values for seed vigour index-I up to 6 months of storage were observed in control.

Vigour index-II

A similar trend for vigour index-II as for vigour index-I up to 9 months of storage (Table 4) was observed. Maximum values for vigour index-II after 1 week and 3, 6 and 9 months of storage (134.66, 117.98, 104.52 and 53.98 respectively) were observed when the seeds were primed with PEG 6000 -1.5 M Pa for 24 h (T_2). This treatment (T_2) was also statistically at par with T_3 (Na_2HPO_4 10^{-3} M for 24 h) and T_5 (KH_2PO_4 10^{-3} M for 24 h) up to 9 months of seed storage after priming. After 12 months of seed storage after priming however maximum vigour index-II (27.23) was recorded in control having no statistical differences with testaments T_2, T_3 and T_5. Minimum values for vigour index-II were observed in control after 1 week of storage in treatment T_{16} for 3, 6 and 9 months after storage and T_6 after 12 months of storage.

The values of vigour index-I and vigour index-II in general decreased as storage period progressed but after the completion of one year there was more vigour in the control seeds which were not at all primed. This may be due to the presence of growth inhibitor which did not leach and the enzymes like catalase, peroxidase, amylase and invertase remained inactive. The present results are in agreement with the findings of Owen and Pill (1994) who also indicated that priming before storage is deleterious to seed longevity in some species.

CONCLUSION

Priming of cucumber seeds with PEG 6000 -1.5 M Pa for 24 h proved to be the best treatment for characters like speed of germination, germination percentage (first and final count), seedling length, seedling dry weight and vigour index-I and II as compared to other priming treatments and non-primed seeds (Control) when tested in the germinator at sub-optimal temperature (15°C). It may be recommended to the growers and seed producers after on-farm testing in multi-location trials for better storage and higher yield in cucumber.

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