 DOI:10.5958/j.0976-4038.5.1.023

Efficacy of Evaporative Cool Chamber in Pasighat Condition, Arunachal Pradesh, India

Ngangbam Piloo[1*] and Eloni Vida[2]

[1]Department of Post-harvest Management, College of Horticulture & Forestry
[2]Krishi Vigyan Kendra, East Siang District, Central Agricultural University, Pasighat, Arunachal Pradesh (791 102), India

Article History

Manuscript No. c441
Received in 14th February, 2013
Received in revised form 8th December, 2013
Accepted in final form 26th February, 2014

Correspondence to

E-mail: ngpiloo@gmail.com

Keywords

Cool chamber, PLW, shelf life

Abstract

Effectiveness of low cost cool chamber -an on-farm rural oriented storage structure which operates on the principle of evaporative cooling developed at IARI, New Delhi was studied under Pasighat condition. Freshly harvested vegetables viz. brinjal, frenchbean, green chillies, coriander and tomatoes were subjected to storage in evaporative cool chamber and ambient condition. The average minimum and maximum temperatures during storage period at cool chamber were 20.4°C and 30.23°C respectively and relative humidity were 74% and 95%, respectively. The minimum and maximum temperatures during storage at room temperature condition were 26.1°C and 31.8°C respectively and relative humidity were 59% and 79% respectively. Results indicate that storage at cool chamber increases the shelf life of all the vegetables by considerably reducing the physiological loss in weight (PLW), retaining sensory quality like colour, texture and increases marketability. Cool chamber was suitable for storing brinjal for 9-15 days, beans and green chillies for 8-10 days, coriander for 3 days and tomatoes for 14-15 days as against 4-5 days for brinjal, beans and green chillies, 1 day for coriander and 7 days for tomatoes in room condition.

1. Introduction

Fruits and vegetables are generally sold in the fresh form during the season of production, owing to the shortage of storage facilities. A simple low cost, natural conditioned on-farm storage structure which is prepared from cheap and easily available materials developed at IARI, New Delhi is suitable for the storage of fruits (mandarin, apple and sweet orange) and vegetables without much spoilage (Roy and Khurdiya, 1982). Zero energy storage structures are generally employed by small farmers with small landholdings, for the storage of fresh fruits and vegetables over a two to three week period. As the name suggests, these structures do not require any energy for operation. Their operation is based on the principle of evaporative cooling whereby the temperature is decreased and the relative humidity increased, creating an environment suited to maintaining the freshness of fruits and vegetables. Thus the present study was undertaken with the objective to study the effectiveness of low cost cool chamber for storage of some common vegetables in Pasighat condition.

2. Materials and Methods

Freshly harvested vegetables viz. brinjal, frenchbean, green chillies, coriander and tomatoes free from blemishes, adhering sand or soil or foreign matters obtained from KVK Farm, East Siang District were used for the experiment. Precautions were taken while handling the produce to minimize abrasions and bruising which leads to accelerated spoilage of vegetables. The vegetables under observation were subjected to washing with clean water and shade drying. The vegetables were then stored in Zero energy cool chamber and in Post harvest Management Laboratory (Ambient/Room temperature condition) of the College of Horticulture and Forestry after putting them in plastic crates. The average minimum and maximum temperatures during storage period at cool chamber were 20.4°C and 30.23°C respectively and relative humidity were 74% and 95%, respectively. The minimum and maximum temperatures during storage at room temperature condition were 26.1°C and 31.8°C, respectively and relative humidity were 59% and 79%, respectively. Observations were recorded on physiological loss in weight, marketable vegetables everyday and sensory quality at two days interval till the vegetables were unacceptable.

3. Results and Discussion

Physiological loss in weight (PLW) of at different storage conditions was significant (5%) at different days of storage

(Table 1). Upto 4th day of storage, the PLW of brinjal stored in cool chamber (T_1) was found to be nil while those in room condition had PLW of 8.52% on 2nd day of storage. On the 4th day of storage, brinjal stored in room condition (T_2) was 13.85% and on 8th day, the brinjals were not available for observation due to rejection owing to very high moisture loss and shrinkage. On 8th day of storage, brinjal stored in cool chamber(T_1) was as low as 2.51% and on the 14th day of storage, it was 5.71%.

PLW (%) of Frenchbeans as affected by different storage conditions was significant (5%) at different days of storage (Table 2). On the 2nd day of storage, PLW (%) of Frenchbeans in cool chamber(T_1) was 2.12% while it was 22.22% in room condition. On the 6th day of storage, PLW was as high as 55.5% in room condition and the Frenchbeans were rejected due to high shrinkage and yellowing. However, in cool chamber, PLW was 5.6% on the 6th day of storage and 8.33% on the 8th day of storage.

The PLW of green chillies was nil upto 2nd day of storage in cool chamber (Table 3) while it was 10% in storage under ambient condition(T_2). On the 6th day of storage, it was as high as 45.52% in room condition (T_2) and the chillies were not available for observation from 7th day onward due to spoilage and shrinkage. In cool chamber(T_1), PLW was 8.65% on 6th day of storage and 20.36% on the 12th day of storage.

PLW (%) of coriander as affected by different storage conditions was significant (5%) at different days of storage (Table 4). On the 2nd day of storage, PLW (%) of coriander in

Table 1: Physiological loss in weight (%) of brinjal during storage in evaporative cool chamber and ambient condition

Treat-ment	Days of storage																Mean
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
T_1	0	0	0	0	1.62	1.90	2.23	2.51	2.75	2.86	3.42	4.79	5.00	5.71	7.89	9.44	3.13
T_2	4.25	8.52	12.77	13.85	14.9	25.53	30.60	-	-	-	-	-	-	-	-	-	6.90
Mean	2.13	4.26	6.39	6.93	8.26	13.72	16.42	1.26	1.38	1.43	1.71	2.4	2.50	2.86	3.95	4.72	
	SEm±	$CD_{0.05}$															
Treat-ment (T)	0.0076	0.0151															
Days (D)	0.0215	0.0429															
T×D	0.0304	0.0607															

T_1=Cool Chamber; T_2=Room condition; - = vegetable already spoilt and disposed

Table 2: Physiological loss in weight (%) of frenchbeans during storage in evaporative cool chamber and ambient condition

Treatment	Days of storage											Mean
	1	2	3	4	5	6	7	8	9	10	11	
T_1	0	2.12	2.87	3.44	4.26	5.60	7.17	8.33	12.59	16.71	19.24	7.48
T_2	7.40	22.22	23.24	27.7	37.04	55.5	-	-	-	-	-	15.69
Mean	3.70	12.17	12.72	15.57	20.65	30.55	3.59	4.17	6.29	8.36	9.62	
	SEm±	$CD_{0.05}$										
Treatment (T)	0.0374	0.0755										
Days (D)	0.0878	0.1769										
T×D	0.1242	0.2503										

Table 3: Physiological loss in weight (%) of green chillies during storage in evaporative cool chamber and ambient condition

Treatment	Days of storage													Mean
	1	2	3	4	5	6	7	8	9	10	11	12	13	
T_1	0	0	0	4.21	6.88	8.65	10.00	12.32	14.87	15.66	17.45	20.36	25.50	10.45
T_2	5.88	10.00	12.34	15.63	25.0	45.52	-	-	-	-	-	-	-	8.80
Mean	2.94	5.00	6.17	9.92	15.94	27.09	5.00	6.16	7.44	7.83	8.73	10.18	12.75	
	SEm±	$CD_{0.05}$												
Treatment (T)	0.0080	0.0161												
Days (D)	0.0205	0.0411												
T×D	0.0290	0.0581												

cool chamber (T_1) was 8.62% while it was 80.99% in room condition (T_2). On the 4th day of storage, PLW was as high as 25% in cool chamber whereas those stored in room condition were rejected due to high shrinkage and yellowing on the 2nd day itself.

Table 5 indicated that PLW of at different storage conditions was significant (5%) at different days of storage. Upto 2nd day of storage, the PLW of tomatoes stored in cool chamber (T_1) was found to be nil while those in room condition had PLW of 11.4% on 2nd day of storage. On the 6th, 10th and 14th day of storage, PLW was 3.22%, 8.65% and 22.6% respectively in cool chamber (T_1). In room condition (T_2), PLW on 6th day was as high as 35.98% and the tomatoes were completely spoilt and not available for observation from 10th day onwards.

Table 4: Physiological loss in weight (%) of coriander during storage in evaporative cool chamber and ambient condition

Treatment	Days of storage				Mean
	1	2	3	4	
T_1	5.78	8.62	12.5	25.0	12.98
T_2	60.53	80.99	91.00	-	58.13
Mean	33.16	44.81	51.75	12.50	
	SEm±	$CD_{0.05}$			
Treatment (T)	0.2558	0.5422			
Days (D)	0.3617	0.7668			
T×D	0.5116	1.0845			

T_1: Cool Chamber; T_2: Room condition; -: Vegetable already spoilt and disposed

Marketable fruits (%) affected by different storage conditions was significant (5%) for different days of storage (Table 6). Upto 6th day of storage, all the brinjals were marketable (100%) in cool chamber while only 40% were marketable in room condition. On the 8th day of storage, there was no marketable fruits for the treatments T_2 (room condition) while percentage of marketable fruits was as high as 90% in T_1 (Cool chamber). On 12th and 14th day of storage, marketable fruits was 60% and 50% respectively in brinjals stored in cool chamber.

Table 7 indicated that marketability of frenchbeans at different storage conditions was significant (5%) at different days of storage. Upto 4th day of storage, T_1 (Cool chamber) has 100% marketable frenchbeans while T_2 (room condition) has 70% marketable frenchbeans. On the 8th day of storage, there were no marketable frenchbeans in T_2 (room condition) while T_1 (Cool chamber) has 60% marketable frenchbeans.On 10th day of storage, marketability of Frenchbeans in cool chamber was 50%.

Table 8 indicated that marketability of green chillies at different storage conditions was significant (5%) at different days of storage. Upto 4th day of storage, T_1 (Cool chamber) has 100% marketable chillies while T_2 (room condition) has 70% marketable chillies. On the 7th day of storage, there were no marketable chillies in T_2 (room condition) while T_1 (Cool

Table 5: Physiological loss in weight (%) of tomatoes during storage in evaporative cool chamber and ambient condition

Treat-ment	Days of storage																Mean
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
T_1	0	0	0	1.56	2.32	3.22	3.68	4.99	6.31	8.65	10.34	13.67	19.35	22.6	25.8	32.26	9.67
T_2	3.22	11.4	18.77	26.7	35.08	35.98	45.16	51.61	67.74	-	-	-	-	-	-	-	18.48
Mean	1.61	5.70	9.39	14.13	18.70	19.60	24.42	28.30	37.02	4.33	5.17	6.84	9.68	11.30	12.90	16.13	
	SEm±	$CD_{0.05}$															
Treat-ment (T)	0.0129	0.0258															
Days (D)	0.0365	0.0730															
T×D	0.0516	0.1032															

Table 6: Marketability (%) of brinjal during storage in evaporative cool chamber and ambient condition

Treatment	Days of storage																Mean
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
T_1	100	100	100	100	100	100	90	90	80	80	70	60	60	50	50	30	78.96
T_2	100	100	90	70	50	40	30	0	0	0	0	0	0	0	0	0	30.00
Mean	100	100	95	85	75	70	60	45	40	40	35	30	30	25	25	15	
	SEm±	$CD_{0.05}$															
Treatment (T)	1.2013	2.3999															
Days (D)	3.3978	6.7880															
T×D	4.8052	9.5996															

Table 7: Marketability (%) of french beans during storage in evaporative cool chamber and ambient condition

Treatment	Days of storage											Mean
	1	2	3	4	5	6	7	8	9	10	11	
T_1	100	100	100	100	100	80	70	60	50	50	30	76.67
T_2	100	95	90	70	50	20	0	0	0	0	0	38.64
Mean	100	97.5	95	85	75	50	35	30	25	25	15	
	SEm±	$CD_{0.05}$										
Treatment (T)	1.6459	3.3171										
Days (D)	3.8599	7.7792										
T×D	5.4588	11.0015										

T_1: Cool Chamber; T_2: Room condition; 0: vegetable already spoilt and disposed

Table 8: Marketability (%) of green chillies during storage in evaporative cool chamber and ambient condition

Treatment	Days of storage													Mean
	1	2	3	4	5	6	7	8	9	10	11	12	13	
T_1	100	100	100	100	90	90	80	70	70	60	50	50	30	76.15
T_2	100	95	80	70	60	40	0	0	0	0	0	0	0	34.23
Mean	100	97.50	90	85	75	65	40	35	35	30	25	25	15	
	SEm±	$CD_{0.05}$												
Treatment (T)	1.4730	2.9557												
Days (D)	3.7553	7.5357												
T×D	5.3109	10.6570												

chamber) has 80% marketable chillies. On 10th and 12th days of storage, marketability of chillies in cool chamber was 60% and 50% respectively.

Marketable coriander (%) affected by different storage conditions was significant (5%) for different days of storage (Table 9). Upto 3rd day of storage, marketable coriander in cool chamber was 70% while only 30% were marketable in room condition. On the 4th day of storage, there was no marketable coriander for the treatment T_2 (room condition) while percentage of marketable coriander was 40% in T_1 (Cool chamber).

Table 10 indicated that marketability of tomatoes at different storage conditions was significant (5%) at different days of storage. Upto 6th day of storage, T_1 (Cool chamber) has 100% marketable tomatoes while T_2 (room condition) has 85% marketable tomatoes. On the 10h day of storage, there were no marketable tomatoes in T_2 (room condition) while T_1 (Cool chamber) has 80% marketable tomatoes. On 12th and 14th days of storage, marketability of tomatoes in cool chamber was 70% and 60% respectively.

Sensory quality was evaluated on the basis of general appearance (i.e. colour, texture) and acceptability depending on the condition of the vegetables. For brinjal (Table 11), on the 4th day of storage, the sensory quality was high as the brinjals were deep purple in colour, glossy and firm in T_1 (Cool chamber) while in room condition (T_2), it was slightly dull with little shrinkage. On the 12th day of storage, the brinjals in cool chamber were still purple in colour, still firm but dull while those in T_2 were unacceptable on the 8th day of storage with very high shrinkage. On the 14th day of storage, the brinjals in T_1 (Cool chamber) were still purple but dull in colour, more shrinkage with 1-2 spots.

For frenchbeans (Table 12), on the 4th day of storage, the sensory quality was high with green and tender pods in T_1 (Cool chamber) while in room condition (T_2), it was yellowing with severe shrinkage and spots. In cool chamber, the pods were light green in colour with constriction and shrinkage on the 8th and 10th day of storage in cool chamber and on the 12th day, the pods were totally yellow with severe shrinkage and black spots all over.

Sensory quality of green chillies was good with no shrinkage upto 4th day of storage in cool chamber (Table 13). However, on the 4th day, sensory quality of green chillies in room condition was low with severe shrinkage, black stalks and completely unacceptable on the 6th day. In cool chamber, on the 8th day of storage all the chillies turned red with shrinkage and on the 12th day, shrinkage was very high with blackened stalks and totally anacceptable on 13th day.

Coriander on the 2nd day of storage in room condition (T_2) were totally yellow and wilted (Table 14).However, in cool chamber (T_1), the coriander were light green in colour with wilting on the 3rd day of storage and completely unacceptable

Table 9: Marketability (%) of coriander during storage in evaporative cool chamber and ambient condition

Treatment	Days of storage				Mean
	1	2	3	4	
T_1	100	90	70	40	75
T_2	95	70	30	0	48.75
Mean	97.50	80	50	20	
	SEm±	$CD_{0.05}$			
Treatment (T)	3.3072	7.0110			
Days (D)	4.6771	9.9151			
T×D	6.6144	14.0221			

T_1: Cool Chamber; T_2: Room condition; 0: vegetable already spoilt and disposed

on the 4th day of storage.

For tomatoes (Table 15), on the 4th day of storage, the sensory quality was high with red and firm tomatoes in T_1 (Cool chamber) while in room condition (T_2), it was less firm with slight shrinkage. On the 14th day of storage in cool chamber, the tomatoes were deep red in colour, very soft with high shrinkage and they were totally spoilt on 16th day of storage.

Results indicate that T_1 (Cool chamber) is the better treatment for storage of vegetables. It increases the shelf life by considerably reducing the PLW, blackening, yellowing, retaining sensory quality, increases marketability. High humidity condition and comparatively low temperature of cool chamber from outside during the period of storage retarded

Table 10: Marketability (%) of tomatoes during storage in evaporative cool chamber and ambient condition

Treatment	Days of storage																Mean
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
T_1	100	100	100	100	100	100	90	90	80	80	70	70	70	60	50	40	81.25
T_2	100	100	100	95	90	85	70	50	40	0	0	0	0	0	0	0	45.63
Mean	100	100	100	97.5	95	92.5	80	70	60	40	35	35	35	30	25	20	
	SEm±	$CD_{0.05}$															
Treatment (T)	1.0520	2.1017															
Days (D)	2.9756	5.9445															
T×D	4.2081	8.4068															

Table 11: Sensory quality of brinjal during storage in evaporative cool chamber and ambient condition

	2 DAS	4 DAS	6 DAS	8 DAS	10 DAS	12 DAS	14 DAS	16 DAS
T_1	Deep purple, glossy, firm	Deep purple, glossy, firm	Deep purple, less glossy, firm	Deep purple, less glossy, firm	Purple, dull color, firm	Purple, dull color, firm	Purple, dull color, slight shrinkage, with 1-2 spots	unacceptable
T_2	Deep purple, glossy, slight shrinkage	Purple, dull, shrinkage	High shrinkage					

T_1: Cool Chamber; T_2: Room condition

Table 12: Sensory quality of frenchbeans during storage in evaporative cool chamber and ambient condition

	2 DAS	4 DAS	6 DAS	8 DAS	10 DAS	12DAS
T_1	Fresh, tender, green	Green, tender	Green, tender, slight shrinkage,	Constriction, light green, more shrinkage	Yellowing, black spots, severe shrinkage	unacceptable
T_2	Green, shrinkage	Light green, constriction with spots	Unacceptable			

Table 13: Sensory quality of green chillies during storage in evaporative cool chamber and ambient condition

	2 DAS	4 DAS	6 DAS	8 DAS	10 DAS	12 DAS	14 DAS
T_1	All green, fresh	Some slight red, fresh	Some deep red, some slight red, shrinkage	All red, shrinkage	All red, more shrinkage, blackening at stalk	All red, high shrinkage, blackening at stalk	Spoilt
T_2	All green, slight shrinkage	Some deep red, some slight red, higher shrinkage with black stalk	unacceptable				

Table 14: Sensory quality of coriander during storage in evaporative cool chamber and ambient condition

	1 DAS	2 DAS	3 DAS	4 DAS
T_1	Fresh green	Green, slightly wilted	Light green, more wilting	Yellow, totally wilted, unacceptable
T_2	Green, wilted	Yellow, Totally wilted, dried,	unacceptable	

T_1: Cool chamber; T_2: Room condition

Table 15: Sensory quality of tomatoes during storage in evaporative cool chamber and ambient condition

	2 DAS	4 DAS	6 DAS	8 DAS	10 DAS	12 DAS	14 DAS	16 DAS
T_1	Turning, firm	Red, firm	Red, less firm	Deep red, slight softening	Deep red, slight softening, slight shrinkage	Deep red, Soft, more shrinkage	Deep red, Soft, more shrinkage	unacceptable
T_2	Turning, less firm	Red, slight shrinkage, less firm	Deep Red, more shrinkage, soft	Deep Red, high shrinkage, very soft				

the metabolic activities through respiration and transpiration. The inside temperature of the cool chamber can be reduced from 43°C outside temperature to 23°C and relative humidity can be increased from 33% to 95% during summer months in North Indian condition (Khurdiya and Roy, 1986). Low physiological loss in weight, low shrinkage in cool chamber increased the shelf life of different vegetables (Khurdiya and Roy, 1986; Pal and Roy, 1988; Srinivasa and Reddy, 2006; Ekka and Chakrabati, 2007).

4. Conclusion

Storage at cool chamber increases the shelf life of all the vegetables by considerably reducing the PLW, retaining sensory quality like colour, texture and increases marketability. Cool chamber was suitable for storing brinjal for 9-15 days, beans and green chillies for 8-10 days, coriander for 3 days and tomatoes for 14-15 days as against 4-5 days for brinjal, beans and green chillies, 1 day for coriander and 7days for tomatoes in room condition in Pasighat condition.

5. References

Ekka, A.B., Chakrabati, A.K., (2007). Quality parameters of okra as influenced by storage, packaging and variety. Journal of Research, Birsa Agricultural University 19, 65-71.

Khurdiya, D.S., Roy, S.K., (1986). Studies on evaporatively cooled zero energy input cool chamber for the storage of Horticultural Products. Indian Food Packer 40, 26-31.

Pal, R.K., Roy, S.K., (1988). Zero energy cool chamber for maintaining post-harvest quality of carrot (*Daucus carota* var. *Sativa*). Indian Journal of Agricultural Sciences 58 , 665-667.

Roy, S.K., Khurdiya, D.S., 1982. Keep vegetables fresh in summer. Indian Horticulture 27, 5-6.

Srinivasa, V., Reddy, T.V., 2006. Post harvest response of palak to packaging and cool chamber storage. Environment and Ecology 24S**,** 1096-1099.