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EFFECT OF SOURCES OF NUTRIENTS AND PACKAGING MATERIALS ON SHELF LIFE OF BOTTLE GOURD FRUITS (*LAGENARIA SICERARIA* (MOL.) STANDL.) AT AMBIENT TEMPERATURE

HEMWANT SINGH[1], SNS CHAURASIA, SUDHIR SINGH, DK SINGH[1] AND AASTIK JHA
Indian Institute of Vegetable Research, Varanasi-221 305, India
[1]Department of Horticulture, U.P. Autonomous College, Varanasi- India

Summary

An experiment was conducted to study change in the quality of bottle gourd (*Lagenaria siceraria* (Mol.) Standl.), fruits stored at ambient room temperature under different packaging materials at Indian Institute of Vegetable Research, Varanasi during summer season of 2008 and 2009. The green and tender fruits of bottle gourd variety cv. Kashi Ganga of the same anthesis date was selected for study and packaged in different types of packaging materials like low density polyethylene (LDPE, 40 x 30 cm) pouches, cardboard boxes (45 x 30 x 20 cm), jute bags (45 x 30 cm), and news paper and kept at ambient room temperature (25 ± 2°C, 72.09-84.0% RH). It was observed, that all the packaging materials were significantly effective for improving the quality parameters and shelf life of bottle gourd as compared to unpacked bottle gourd fruits. Physiological loss in weight in stored bottle gourd fruits was significantly low (18.12%) in LDPE pouches as compared to jute bags (21.25%) after 12 days of storage. Similarly the spoilage percentage was also significantly less in jute bags and LDPE pouches as compared to other packaging materials. The total soluble solids (TSS) content increased with increasing the storage period of fruit in all packaging materials whereas, the titratable acidity and ascorbic acid contents were decreased. The maximum (5.72%) TSS was recorded under with T_{12} (NPK 60 : 30 : 30 kg/ha + vermicompost @ 5 t/ha + micronutrients mixtures) with news paper packaging after 12 days of storage. The minimum (0.13% as citric acid) acidity was recorded in T_{13} (NPK 60: 30:30 kg/ha + vermicompost @ 5 t/ha + micronutrients mixture) after 12 days of storage and maximum (7.16 mg/100g) vitamin c was noted in T7 (NPK 60: 30:30 kg/ha + Poultry manure @ 5 t/ha) during 3 days of storage in LDPE pouches.

सारांश

लौकी की विभिन्न प्रकार के पैकिंग में कमरे के तापमान पर भण्डारित करके विभिन्न अवधि के उपरान्त फलों में हो रहे बदलाव को ज्ञात करने के लिए भारतीय सब्जी अनुसंधान संस्थान, वाराणसी में वर्ष 2008 व 2009 में लौकी की किस्म काशीगंगा के उपर एक प्रयोग किया गया और भण्डारण के लिए एक ही उम्र के फलों को विभिन्न प्रकार के पैकिंग मेटेरियल जैसे एल.डी.पी.ई. पौच, कार्ड वोर्ड वाक्स, जूट वैग व समाचार पत्र में पैक करके रखा गया। प्रयोगों से यह देखा गया कि फलों में सामान्य की अपेक्षा सभी प्रकार के पैंकिगमटेरियल का अच्छा प्रभाव रहा। भण्डारण अवधि 3, 6, 9 व 12 दिनों के उपरान्त विभिन्न गुणों का जाँच करने के उपरान्त यह देखा गया कि 12 दिनों के भण्डारण के पश्चात् एल.डी. पी.ई. पौच में भण्डारित फलों के वजन में सबसे कम गिरावट रही जबकि एसीडिटी व एस्कार्विक अम्ल की मात्रा में गिरावट देखी गयी। टी.एस. एस. की सर्वाधिक मात्रा 5.72 टी–12 (एन.पी.के. 60:30:30 कि./हे. + वर्मी कम्पोस्ट @5 टन/हे. + शुक्ष्मतत्व के पर्णीय छिड़काव) वालों फलों की समाचार पत्रों में पैकिंग में रही। वही सर्वाधिक विटामिन 'सी' की मात्रा टी.–7 (एन.पी.के. 60:30:30 कि./हे.+पोल्ट्री मैन्योर @5 टन/हे.) के प्रयोग से तीन दिनों के भण्डारण के उपान्त एल.डी.पवी.ई. पाउच वाले पैकिंग में रहीं टाइट्रेबुल अम्लीयता व एस्कार्बिक अम्ल की मात्रा में भण्डारण अवधि के बढ़ानें से गिराबट दर्ज की गयी।

Introduction

Among the cucurbits, bottle gourd (*Lagenaria siceraria* (mol.) standl.) is one of the most important and widely grown vegetable crops of India. The fruits in green and tender stage are used as vegetable and for preparation of sweets, raiyta, pickles and different dishes. The application of pre harvested treatments like organic and inorganic production system may also play important role in improving the fruit quality (Mishra *et al*., 1999 and Sukhada Mohandas 1999). Azcon *et al*. (1975) further attributed that different sources of nutrients such as organic/inorganic and integrated had significant effect on the physiological and biochemical changes in bottle gourd fruits. The storage temperature, packaging materials and the gaseous environment around the product is responsible for changes in the quality of bottle gourd fruits under storage. The packaging and storage of harvested vegetables in India is highly unorganized. The present experiment was, therefore, undertaken to

know the enhance in quality of bottle gourd fruits under storage by different packaging materials at ambient conditions.

Materials and Methods

The experiment on the effect of different 13 IPNM treatments consisting of NPK (120:60;60 kg/ha, T1, FYM @20 t/ha, T2, Vermicompost @10 t/ha, T3, Poultry manure @10 t/ha, T4, ½ NPK + FYM @10 t/hac, T5, ½ NPK + Vermicompost @5 t/hac, T6, ½ NPK + Poultry manure @5 t/ha, T7, ½ NPK + FYM @10 t/ha + Azospirillum, T8, ½ NPK + Vermicompost @ 5 t/ha + Azospirillum, T9, ½ NPK + Poultry manure @ 5 t/ha + Azospirillum, T10, ½ NPK + FYM @10 t/ha + micronutrients mixture, T11, ½ NPK + Vermicompost @ 5 t/ha + micronutrients mixture, T12, ½ NPK + Poultry manure @5 t/ha + micronutrients mixture, T13) nutrients and four packaging materials (LDPE pouches, cardboard boxes, Jute bags and news paper) and replicated thrice to study the quality of bottle gourd fruits stored at ambient temperatures (25 ± 2^0C and RH 72.09 to 84.00%) at IIVR, Varanasi during the period of 2008-2009. Selected fruits of bottle gourd cv. Kashi Ganga of similar anthesis date were packed in different packaging materials and analyzed for physico-chemical analysis during storage at three days interval to assess the quality of bottle gourd fruits during storage. The physiological loss in weight was carried out by determining the weight difference during storage in different packaging materials during storage (Ranganna, 1986). The percent spoilage was carried out by counting the number of fruits which showed the symptoms of spoilage and were judged by the panel of judges and were expressed as percentage of spoilage by physical spoilage. The total soluble solids (TSS) in bottle gourd after the storage for three days in all packaging materials were cut into small pieces and were blended in electrical mixer. The extracted juice in two layered muslin cloth was subjected to measurement of TSS with hand refractometer (0-32%). Vitamin 'C' content of freshly harvested and stored fruits was calculated by the reduction of 2,6 Dichloroindophenol dye as described by Ranganna (1986).

Results and discussion

Physiological loss in weight: It was evident from the Table 1 that weight loss in all bottle gourd samples packaged in different packaging materials occurred during storage. After 3 days of storage, it was also noted that the minimum PLW (3.89 %) was observed in T_{12} (NPK 60:30:30 kg/ha. +Vermicompost @ 5 t/ha+ micronutrients mixture) under LDPE packaged fruits followed by 4.04% in T_{13} (NPK ½ poultry manures + micronutrients mixture) under the same packaging materials (Table 1). The maximum loss 9.90% was noted in under T_1 (NPK 120: 60: 60 kg/ha) in news paper packaged fruits. This is followed by the treatmentsT_7 (NPK ½ + poultry manures@ 5 t/ha)

Table 1. Physiological loss in weight (%) in IPNM treated bottle gourd under different packaging materials during storage at ambient temperature

Treatments		News paper				Cardboard boxes				Jute bags				LDPE pouches			
		Period of storage (Days)				Period of storage (Days)				Period of storage (Days)				Period of storage (Days)			
		3	6	9	12	3	6	9	12	3	6	9	12	3	6	9	12
T1	NPK (120 : 60 : 60 Kg/ha)	9.90	25.06	31.90	41.65	8.67	21.78	26.12	30.72	6.38	17.31	22.46	24.99	5.40	15.20	20.04	23.03
T2	FYM @ 20 t/ha	9.13	26.22	30.96	37.22	8.38	20.90	22.82	27.11	6.05	16.07	19.35	24.75	5.43	13.52	17.11	20.17
T3	Vermicompost @ 10 t/ha	8.97	25.80	31.46	36.01	8.09	19.74	21.76	24.86	6.05	13.61	16.46	23.53	4.73	12.27	16.34	20.23
T4	Poultry Manure @ 10 t/ha	8.95	24.49	34.57	38.07	8.64	19.30	21.09	25.29	6.25	13.65	16.81	23.75	5.34	11.32	15.92	20.42
T5	1/2 NPK + FYM @ 10 t/ha	9.09	23.99	31.19	36.46	8.71	17.38	21.72	25.75	6.14	13.17	16.97	23.95	4.73	13.61	17.53	21.06
T6	1/2 NPK + Vermicompost @ 5 t/ha	8.87	24.64	29.84	34.64	8.12	18.86	21.50	24.62	5.58	14.23	16.93	23.68	4.41	13.34	17.30	20.09
T7	1/2 NPK + Poultry Mannure @ 5 t/ha	9.31	24.44	29.70	35.30	8.50	18.87	21.68	25.28	5.69	14.25	18.00	23.93	4.53	11.91	17.04	20.34
T8	1/2 NPK + FYM @ 10 t/ha + Azospirillum	8.86	24.30	28.83	35.26	8.40	19.45	22.45	26.59	5.73	13.56	18.15	23.77	4.35	10.23	16.46	20.27
T9	1/2 NPK + Vermicompost @ 5 t/ha + Azospirillum	8.64	22.48	28.25	34.88	8.01	18.73	22.11	25.21	5.58	12.44	16.96	22.08	4.34	11.55	16.53	19.36
T10	1/2 NPK + Poultry Mannure @ 5 t/ha + Azospirilum	9.06	22.56	30.60	35.12	8.18	16.31	22.94	26.45	5.72	12.87	16.92	23.45	4.24	11.64	17.41	19.69
T11	1/2 NPK + FYM @ 10 t/ha + micronuterients mixture	8.55	22.72	27.78	33.41	8.22	19.60	23.37	25.79	5.71	12.18	18.39	22.87	4.15	11.51	17.01	18.58
T12	1/2 NPK + Vermicompost @ 5 t/ha + micronuterients mixture	7.09	21.94	25.29	31.01	8.34	17.47	21.40	24.90	5.42	11.82	15.55	21.25	3.89	10.29	15.23	18.12
T13	1/2 NPK + Poultry Mannure @ 5 t/ha + micronuterients mixture	8.25	22.15	29.16	32.86	8.69	18.58	22.43	24.13	5.71	14.24	17.09	22.64	4.04	11.36	17.11	19.45
SEm ±		0.18	0.57	0.77	0.93	0.35	0.89	1.64	0.68	0.20	0.35	0.47	0.31	0.17	0.69	0.32	0.24
CD (P = 0.05)		0.54	1.66	2.27	2.72	NS	2.60	4.80	2.00	NS	1.0	1.39	0.91	0.51	2.02	1.11	0.72

when the loss percentage was 9.31% under same packaging materials. The physiological loss in weight was increased after 6 days of storage as compared to the 3 days of storage under each treatment (Table 1). The minimum physiological loss in weight was recorded as 10.29% in T_{12} (NPK 60:30:30 kg/ha + vermicompost @ 5 t/ha + micronutrients mixture) under LDPE packaged fruits followed by 10.23% in T_8 (NPK 60:30:30 kg/ha + FYM @10 t/ha + *Azospirillum*) under LDPE packaged fruits. None of the treatments showed the similarity within the treatments. However, maximum (26.22%) physiological loss in weight at 6 days of storage was noted in T_2 (FYM @ 20 t/ha) under news paper packaged fruits. The similar trend was observed after 9th days of storage. After 9 days of storage the minimum (15.23%) loss was recorded in T_{12} (NPK 60:30:30 kg/ha + vermicompost @ 5t/ha + micronutrients mixture) bottle gourd fruits when packaged in LDPE which was closely followed by T_4 (15.92 %) under same storage conditions (Table 1). However, the treatment T_3 (vermicompost @ 10 t/ha) under the similar storage condition was noted at par with T_{12} treatment in weigt loss during storage at ambient temperature. The maximum (34.57%) loss in weight at 9th days of storage was recorded in T_4 (Poultry manures @10 t/ha) packed under news paper. As the fruits were healthy after 9th days of storage it was continued up to 12 days of storage and recorded that the losses in fruits had reached up to 18.12% in T_{12} (NPK 60 :30:30 Kg/ha + vermicompost @ 5 t/ha + micronutrients mixtures) packaged under LDPE pouches (Table 1). The maximum (41.65%) losses after 12 days of storage was recorded under T1 (NPK 120: 60: 60 kg/ha) treated bottle gourd fruits packaged in news paper. It is quite clear from the results that the losses were minimum in LDPE packaged bottle gourd fruits at all the stages of storage (3, 6, 9 and 12 days of storage) while the maximum losses were observed in newspaper packed fruits.

The minimum losses in weight under LDPE packaged fruits might be due to the reason that organic sources of nutrients improved the quality of the fruits and also reduces the transpiration rate (Chaurasia *et al*., 2001). Excessive weight loss at news paper packed fruits of bottle gourd was due to increase in transpiration rate which adversely affected the quality of the bottle gourd fruits. This may be attributed due to loose packing between the aerial portion of bottle gourd and news paper as a result of more exposure of surface area. Our findings were supported by other workers that polyethylene packaging materials were found to best in reducing the weight loss of different vegetables (Golomb *et al*., 1984, Purvis 1984, Begliomini *et al*., 1995; Farooqi *et al*., 1995).

Extent of spoilage: The maximum spoilage (18.83 %) was recorded with T_1 (NPK 120: 60: 60 kg/ ha) treated fruits packed in newspaper which was followed by 16.39 % in T_2 (FYM @ 20 t/ha) under same packaging

Table 2. Spoilage (%) in bottle gourd fruits under different packaging materials during storage at ambient room temperature

Treatments		News paper				Cardboard boxes				LDPE pouches				Jute bags			
		Period of storage (Days)				Period of storage (Days)				Period of storage (Days)				Period of storage (Days)			
		3	6	9	12	3	6	9	12	3	6	9	12	3	6	9	12
T1	NPK (120 : 60 : 60 Kg/ha)	18.83	45.45	63.52	72.26	10.84	43.72	57.41	63.59	6.68	19.23	31.28	47.65	5.56	15.97	23.49	41.07
T2	FYM @ 20 t/ha	16.39	45.80	66.68	72.77	10.49	44.03	58.38	67.17	6.14	16.97	30.72	44.21	5.32	14.93	24.38	41.60
T3	Vermi Compost @ 10 t/ha	15.49	37.81	61.31	68.09	9.79	44.63	56.11	61.83	5.60	14.93	26.80	43.39	5.12	14.16	21.87	35.65
T4	Poultry Manure @ 10 t/ha	15.92	41.94	62.15	72.88	10.28	45.19	57.38	62.50	6.12	16.61	28.32	44.25	5.12	14.95	22.68	37.76
T5	1/2 NPK + FYM @ 10 t/ha	16.22	45.18	61.06	71.38	10.47	45.96	58.41	63.96	5.83	14.76	28.41	43.27	5.40	14.03	22.89	36.54
T6	1/2 NPK + Vermicompost @ 5t/ha	15.97	41.22	62.97	69.12	9.96	44.88	58.20	63.21	5.49	15.08	24.96	37.45	5.13	13.97	22.16	33.99
T7	1/2 NPK + Poultry Manure @ 5 t/ha	16.12	44.63	67.45	66.84	10.13	44.49	56.27	64.22	5.58	16.13	25.38	36.97	5.32	13.59	23.01	33.74
T8	1/2 NPK + FYM @ 10 t/ha + Azospirillum	15.78	42.83	60.25	67.08	10.16	44.50	55.90	63.04	5.52	15.85	26.20	36.02	4.72	13.03	22.64	33.48
T9	1/2 NPK + Vermicompost @ 5 t/ha + Azospirillum	15.58	43.99	60.10	64.65	9.43	42.07	54.58	62.31	5.20	13.97	25.66	34.91	4.57	12.56	21.62	35.07
T10	1/2 NPK + Poultry Manure @ 5 t/ha + Azospirillum	15.57	42.55	61.55	65.48	9.82	42.55	55.68	63.70	5.56	14.45	26.04	34.29	4.74	13.33	22.55	33.68
T11	1/2 NPK + FYM @ 10 t/ha + micronutrients mixture	15.29	39.18	60.25	66.04	9.84	42.12	55.48	62.99	5.44	14.10	25.18	33.10	4.51	12.77	21.59	31.65
T12	1/2 NPK + Vermicompost @ 5 t/ha + micronuterients mixture	14.80	40.89	59.28	67.46	9.01	38.68	52.33	60.77	4.94	13.26	22.64	31.52	4.21	12.33	21.12	33.03
T13	1/2 NPK + Poultry Manure @ 5 t/ha + micronutrients mixture	15.10	44.75	64.84	71.54	9.50	39.74	54.24	60.92	5.27	14.37	25.62	33.28	4.52	12.75	21.29	36.45
SEm ±		0.27	1.00	0.96	0.94	0.15	1.43	0.77	0.68	0.13	0.34	0.39	1.36	0.13	0.29	0.13	0.84
CD (P = 0.05)		0.80	2.92	2.82	2.75	0.46	4.18	2.26	2.00	0.40	1.00	1.15	3.99	0.40	0.85	0.40	2.46

Table 3. Total soluble solids (%) in IPNM treated bottle gourd fruit under different packaging materials during storage at ambient room temperature

Treatments		T.S.S. (%)	News paper				Cardboard boxes				Jute bags				LDPE pouches			
			Period of storage (Days)				Period of storage (Days)				Period of storage (Days)				Period of storage (Days)			
			3	6	9	12	3	6	9	12	3	6	9	12	3	6	9	12
T_1	NPK (120 : 60 : 60 Kg/ha)	3.93	4.01	4.35	4.90	5.40	3.21	3.47	3.81	4.15	3.82	4.42	4.74	5.22	3.55	3.68	3.86	4.69
T_2	FYM @ 20 t/ha	3.60	3.86	4.19	4.18	5.06	3.77	3.98	4.42	4.67	4.31	4.71	5.17	5.34	3.58	3.75	3.92	4.20
T_3	Vermi Compost @ 10 t/ha	4.23	4.24	4.61	4.70	5.50	3.32	3.46	3.77	4.14	3.61	3.89	4.26	4.84	3.66	4.00	4.25	4.56
T_4	Poultry Manure @ 10 t/ha	3.17	3.38	3.98	4.49	4.98	3.58	3.99	4.41	4.71	3.38	3.89	4.06	4.54	3.58	3.80	4.09	4.32
T_5	1/2 NPK + FYM @ 10 t/ha	3.03	3.61	4.18	4.61	5.10	3.56	3.88	4.74	4.91	3.33	3.94	4.21	4.59	3.64	3.79	4.27	4.50
T_6	1/2 NPK + Vermicompost @ 5t/ha	3.77	3.84	4.32	4.73	5.05	3.50	3.82	4.16	4.48	3.73	4.23	4.20	4.52	3.67	3.85	4.14	4.39
T_7	1/2 NPK + Poultry Manure @ 5 t/ha	3.50	3.77	4.06	4.47	5.02	3.48	3.82	4.14	4.71	3.91	4.01	4.27	4.49	3.56	3.85	4.24	4.56
T_8	1/2 NPK + FYM @ 10 t/ha + Azospirillum	3.63	3.98	4.40	4.79	5.14	3.29	3.80	4.31	4.49	3.62	4.26	4.41	4.65	3.73	3.78	3.98	4.30
T_9	1/2 NPK + Vermicompost @ 5 t/ha + Azospirillum	4.13	4.23	4.64	5.28	5.61	3.56	3.82	4.24	4.79	3.87	4.16	4.42	4.84	3.64	4.18	4.53	4.09
T_{10}	1/2 NPK + Poultry Manure @ 5 t/ha + Azospirillum	3.63	3.91	4.43	4.89	5.18	3.71	4.08	4.42	4.90	3.79	4.33	4.52	5.06	3.81	4.26	4.66	4.63
T_{11}	1/2 NPK + FYM @ 10 t/ha + micronutrients mixture	3.33	4.12	4.48	4.92	5.24	3.05	3.54	4.06	4.29	3.42	4.09	4.37	4.61	3.92	4.15	4.59	4.77
T_{12}	1/2 NPK + Vermicompost @ 5 t/ha + micronuterients mixture	3.73	4.29	4.76	5.23	5.72	3.28	3.62	4.65	4.92	4.28	4.42	4.68	4.89	4.22	4.34	4.44	4.84
T_{13}	1/2 NPK + Poultry Manure @ 5 t/ha + micronutrients mixture	3.07	4.06	4.53	5.16	5.63	3.13	3.44	4.46	4.75	3.84	4.06	4.46	4.77	4.39	4.43	4.52	4.67
SEm ±		0.31	0.12	0.14	0.15	0.12	0.08	0.10	0.15	0.17	0.22	0.20	0.24	0.25	0.11	0.10	0.11	0.10
CD(P=0.05)		0.94	0.37	0.42	0.43	0.37	0.24	0.29	0.44	0.52	NS	NS	NS	NS	0.33	0.30	0.34	0.30

materials. However after 6 days of storage, the minimum (12.33%) spoilage occurred in T_{12} (NPK ½ vermicompost @ 5 t/ha + micronutrients mixture) followed by 12.56% in T_9 (NPK ½ vermicopost @5 t/ha+ micronutrients mixture) under the jute bag packaged fruits (Table 2). It is indicated that with increase in the storage period there has been increase in the magnitude of spoilage under all the treatments. The maximum (45.80%) spoilage after 6th days of storage was under news paper packaged fruits in treatment T_2 (FYM @ 20 t/ha). The similar trend was also noted after 9th days of storage. After 9th days, the minimum (21.12%) spoilage was recorded with T_{12} (NPK 60: 30: 30 kg/ha + vermicompost @ 5t/ha + micronutrients mixture) under jute bag packaged fruits which was closely followed by 21.29% with T_{13} (NPK 60: 30: 30 kg/ha + Poultry manures @ 5 t/ha +micronutrients mixture) under same packaging materails. The maximum (67.45%) spoilage at 9th days of storage was recorded in T_7 (NPK 60: 30:30 kg/ha + Poultry manures @ 5 t/ha) packaged under news paper (Table 2). As the fruits were healthy after 9th days of storage, it was continued up to 12th days of storage and was observed that the spoilage in fruits were gone up to 31.65% under T_{12} (NPK 60: 30: 30 kg/ha + Vermicompost @ 5 t/ha+ micronutrients mixtures) treatment followed by 31.52% spoilage in T_{11} treated bottle gourd fruits packaged in jute bags. The maximum (72.77%) losses were recorded with T_2 (FYM @ 20 t/ha). It was quite clear from the results that the spoilage was minimum at all the stages of storage (3, 6, 9 and 12 days) under jute bag and the maximum spoilage was seen under news paper packed fruits. This might be due to the fact that jute bag packaged fruits performed better respiration as compared to the packaged fruits in LDPE pouches, news paper and card board boxes packed fruits where the respiration was not proper which leads to injury and growth of pathogenic microorganisms (Ladaniya *et al.,* 2004 and Begliomini *et al.*, 1995). These results were in conformity with the results of Kalra *et al.*(1989), Shewfelt (1986) and Brar *et al.* (2000) who have reported that polythene packing provide modified atmosphere consequently reduced weight loss and increased the spoilage percentage in bottle gourd and other vegetable crops.

Total soluble solids: The results on the changes in TSS content of freshly harvested and stored bottle gourd fruits in different packaging materials is presented in Table 3. The increasing trend in TSS (%) in all treatments during storage was noticed in all packaging materials. The maximum TSS (4.98-5.72%) was observed in fruits wrapped in news paper followed by fruits packaged in Jute bags (4.49- 5.34%) and card board boxes (4.14 - 4.92%) up to 12 days of storage (Table 3). However, minimum TSS was recorded in fruits packaged in poly bags (4.09-4.84%). The increase

Table 4. Acidity (%) content in IPNM treated bottle gourd fruits under different packaging materials during storage at ambient temperature

Treatments	NPK (120 : 60 : 60 Kg/ha)	Acidity (%)	News Paper				Corrugated Fiber box				Jute Bags				Poly Bags			
			Period of storage (Days)				Period of storage (Days)				Period of storage (Days)				Period of storage (Days)			
			3	6	9	12	3	6	9	12	3	6	9	12	3	6	9	12
T_1	FYM @ 20 t/ha	0.39	0.36	0.32	0.25	0.15	0.35	0.32	0.24	0.14	0.36	0.30	0.23	0.15	0.40	0.36	0.29	0.25
T_2	Vermi Compost @ 10 t/ha	0.38	0.36	0.30	0.26	0.14	0.36	0.33	0.28	0.17	0.41	0.37	0.26	0.16	0.36	0.28	0.20	0.15
T_3	Poultry Manure @ 10 t/ha	0.38	0.36	0.31	0.24	0.15	0.35	0.33	0.28	0.18	0.36	0.32	0.27	0.19	0.34	0.27	0.23	0.17
T_4	1/2 NPK + FYM @ 10 t/ha	0.42	0.38	0.34	0.27	0.12	0.41	0.38	0.31	0.21	0.40	0.37	0.30	0.16	0.37	0.29	0.22	0.16
T_5	1/2 NPK + Vermicompost @ 5t/ha	0.43	0.35	0.31	0.27	0.13	0.42	0.40	0.33	0.18	0.37	0.31	0.27	0.17	0.36	0.28	0.23	0.16
T_6	1/2 NPK + Poultry Manure @ 5 t/ha	0.43	0.37	0.31	0.28	0.18	0.41	0.39	0.31	0.23	0.41	0.37	0.30	0.20	0.38	0.33	0.24	0.17
T_7	1/2 NPK + FYM @ 10 t/ha + Azospirillum	0.47	0.36	0.29	0.25	0.17	0.41	0.38	0.31	0.19	0.40	0.36	0.29	0.21	0.31	0.26	0.23	0.17
T_8	1/2 NPK + Vermicompost @ 5 t/ha + Azospirillum	0.48	0.37	0.32	0.27	0.18	0.45	0.42	0.34	0.19	0.36	0.30	0.27	0.19	0.36	0.28	0.24	0.16
T_9	1/2 NPK + Poultry Manure @ 5 t/ha + Azospirillum	0.45	0.38	0.30	0.26	0.16	0.40	0.36	0.33	0.19	0.39	0.37	0.28	0.18	0.38	0.28	0.22	0.16
T_{10}	1/2 NPK + FYM @ 10 t/ha + micronutrients mixture	0.40	0.39	0.33	0.28	0.15	0.40	0.37	0.30	0.21	0.40	0.36	0.32	0.18	0.38	0.29	0.24	0.18
T_{11}	1/2 NPK + Vermicompost @ 5 t/ha + micronuterients mixture	0.48	0.36	0.29	0.25	0.16	0.43	0.37	0.32	0.19	0.43	0.37	0.29	0.17	0.35	0.32	0.25	0.19
T_{12}	1/2 NPK + Poultry Manure @ 5 t/ha + micronutrients mixture	0.44	0.39	0.35	0.33	0.14	0.41	0.40	0.31	0.24	0.47	0.43	0.29	0.21	0.32	0.26	0.19	0.23
T_{13}	1/2 NPK + Poultry Manure @ 5 t/ha + micronutrients mixture	0.44	0.39	0.35	0.33	0.14	0.41	0.40	0.31	0.24	0.47	0.43	0.29	0.21	0.32	0.26	0.19	0.23
T_{13}	SEm ±	0.45	0.36	0.32	0.27	0.14	0.42	0.38	0.33	0.24	0.46	0.42	0.28	0.20	0.38	0.34	0.28	0.13
SEm ±	CD (P=0.05)	0.023	0.0095	0.01	0.014	0.019	0.023	0.017	0.0085	0.015	0.021	0.016	0.0093	0.007	0.0068	0.0087	0.0088	0.0062
CD(P=0.05)		0.069	0.027	0.03	0.043	NS	0.069	0.049	0.024	0.046	0.063	0.047	0.027	0.021	0.019	0.085	0.025	0.018

in TSS content during storage might be reflected due to loss of more moisture loss from the aerial surface of fruits and concentration of soluble solids. The present findings are in conformity with the findings of Singh and Katiyar (1999) and Chaurasia *et al* (2002).

Titratable acidity: The results on changes in titratable acidity of freshly harvested and stored fruits in different packaging material for 12 days of storage period are presented in Table 4. The acidity level in bottle gourd juice decreased with increase the period of storage in all the treatments. The maximum (0.13%) decrease in acid contents was observed in news paper packed fruits under T_{13} (NPK 60:30:30kg/ha + poultry manures @ 5 t / ha + micronutrients mixture) followed by (0.15%) in T_2 (FYM @ 20t/ha) jute bags wrapped fruits (Table 4). Similar findings have also been reported by Ladaniya (2004), Castro *et al*.(2005), Will *et al*. (1981). The authors were of the opinion that amount of organic acid usually decreases during maturity because organic acids serve as substrate for

Table 5: Vitamin C content (mg / 100 gm) in IPNM treated bottle gourd fruit under different packaging materials during storage at ambient temperature

Treatments		News paper				Cardboard boxes				Jute bags				LDPE pouches			
		3	6	9	12	3	6	9	12	3	6	9	12	3	6	9	12
T_1	FYM @ 20 t/ha	6.38	5.58	5.16	4.83	6.41	4.75	4.39	3.58	6.07	5.29	4.68	4.25	6.84	5.93	5.31	4.93
T_2	Vermi Compost @ 10 t/ha	6.21	5.48	4.92	4.68	6.67	4.86	3.95	3.04	5.79	4.94	4.48	3.98	7.09	6.06	5.76	5.30
T_3	Poultry Manure @ 10 t/ha	6.97	5.84	5.19	4.55	6.66	4.86	4.40	3.64	5.46	4.78	4.26	3.99	6.79	6.18	5.55	5.14
T_4	1/2 NPK + FYM @ 10 t/ha	6.61	5.65	5.14	4.58	6.69	5.14	4.36	3.18	5.77	5.50	4.73	4.17	6.81	6.39	5.78	4.43
T_5	1/2 NPK + Vermicompost @ 5t/ha	6.08	5.78	5.22	4.58	6.65	5.20	4.28	3.31	5.89	5.75	4.86	4.10	6.99	5.82	5.23	4.83
T_6	1/2 NPK + Poultry Manure @ 5 t/ha	6.38	5.26	5.05	4.99	6.51	5.33	4.09	3.12	5.00	4.82	4.07	3.68	6.70	6.02	5.54	5.21
T_7	1/2 NPK + FYM @ 10 t/ha + Azospirillum	6.34	5.70	5.03	4.56	6.51	5.48	4.63	3.65	5.50	4.81	4.15	3.74	7.16	6.08	5.64	5.29
T_8	1/2 NPK + Vermicompost @ 5 t/ha + Azospirillum	6.38	5.14	5.17	4.78	6.49	5.45	4.61	3.64	5.89	5.38	4.53	4.27	6.69	5.92	5.32	5.02
T_9	1/2 NPK + Poultry Manure @ 5 t/ha + Azospirillum	6.74	5.36	5.28	4.58	6.54	5.22	4.74	3.48	5.62	5.51	4.54	3.61	7.14	5.96	5.46	5.04
T_{10}	1/2 NPK + FYM @ 10 t/ha + micronutrients mixture	6.59	5.39	5.20	4.36	6.59	5.28	4.16	3.46	5.77	5.45	4.69	3.41	6.73	6.48	5.88	5.43
T_{11}	1/2 NPK + Vermicompost @ 5 t/ha + micronuterients mixture	6.61	5.31	5.40	4.66	6.70	5.38	4.35	3.61	5.84	5.39	4.68	4.20	7.20	6.60	5.76	5.34
T_{12}	1/2 NPK + Poultry Manure @ 5 t/ha + micronutrients mixture	6.16	5.32	5.20	4.39	6.93	5.55	4.60	3.89	5.94	5.74	4.86	4.41	7.38	6.66	6.29	6.01
T_{13}	1/2 NPK + Poultry Manure @ 5 t/ha + micronutrients mixture	6.55	5.28	5.29	4.56	6.83	5.06	4.29	3.47	5.75	5.52	4.50	4.15	7.10	6.55	6.15	5.73
SEm ±		0.23	0.12	0.122	0.08	0.08	0.18	0.19	0.15	0.16	0.16	0.21	0.17	0.11	0.13	0.13	0.12
CD (P=0.05)		0.67	0.35	0.35	0.24	0.24	0.52	0.57	0.46	0.46	0.48	0.63	0.52	0.33	0.40	0.39	0.35

respiration. The decrease in titrable acidity after seven days coincided with a better sensory score for evaluation in stored fruit.

Ascorbic acid : The decreasing level of ascorbic acid content in bottle gourd fruits during storage in all the treated fruits in different packaging materials is presented in Table 5. The lowest (6.01 mg/100 g) vitamin C content was recorded in T_{12} (NPK 60:30:30 kg/ha+ vermicompost @ 5 t/ha+ micronutrients mixture) followed by 5.73 mg/100g in T_{13} (NPK 60:30:30 kg/ha +poultry manures@5t/ha+ micronutrients mixture) during storage (Table 5). Sharma *et al* (1992) have also reported the decreasing level of vitamin C content during storage in guava. The similar results were also recorded by Hardenberg *et al*. (1986), Brar *et al*. (2000) and Singh *et al*. (1990) during subsequent studies towards the losses of vitamin C content during storage. It is evident from our results that the quality of bitter gourd is significantly dependent on the packaging materials. The storability of fruits can be said as observed in the present experiment is dependent on the packaging materials. The biochemical changes during storage affect the quality of fruit.

It is concluded that LDPE pouches were found to be the best packaging materials for increasing the shelf life and quality of bottle gourd fruits. Among all the IPNM treatments, FYM +1/2 NPK + micronutrient mixtures exhibited the best combinations regarding maintaining the quality and shelf life of bottle gourds.

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