Madras Agric. J., 103 (1-3): 67-71, March 2016

Effect of Pre-harvest Treatments on Storage and Quality of Aggregatum Onion in Ventilated Storage Structure

C. Indu Rani*
Department of Food and Agricultural Process Engineering,
Agricultural Engineering College and Research Institute, Tamil Nadu Agricultural University, Coimbatore - 641003

The effects of pre-harvest treatments on long term storage of aggregatum onion (*Allium cepa* L. var. aggregatum) cv. CO(On)5 were studied. Thirteen pre-harvest treatments *viz.*, cycocel, ethrel and kinetin were used individually and also in combination with ridomil, sprayed at different levels at 15 and 30 d before harvest for improving the quality and storage life of aggregatum onion. Harvested bulbs were pre-cured in the field for three days and in shade for two days. Onion bulbs retained with 2 cm neck length recorded lower reduction of physiological loss in weight and control of sprouting. Cured bulbs were stored under low cost, bottom ventilated storage structure for three months for assessing the quality and shelf life. Among the pre-treatments, application of cycocel @ 200 ppm + ridomil @ 0.2% spray at 30 d before harvest and stored with 2 cm neck length in low cost, bottom ventilated storage structure showed increased shelf life with aggregatum onion cv. CO(On)5.

Key Words : Pre-treatment, Aggregatum onion, Ventilated storage, Quality

Onion (*Allium cepa* L. var. aggregatum) is valued as a condiment due to its flavour and it is the most important bulbous vegetable grown in India. It is one of the potential foreign exchange earners among the vegetables, where India figures prominently in the export market. Onion is commercially cultivated over 100 countries. India stands first in sharing 8 % of the world production with an average cultivated area of 1.06 million ha and an average annual production of 15.18 million tones (NHB 2014-15). The major onion producing states are Maharashtra, Bihar, Karnataka, Gujarat, Andhra Pradesh, Uttar Pradesh, Orissa, Madhya Pradesh and Tamil Nadu. In Tamil Nadu, aggregatum onion is cultivated in 0.04 million ha with a total production of 0.47 million tonnes (NHB 2014-15). The Agricultural and Processed Food Products Export Development Authority (APEDA) of India has identified onion as one of the traditional vegetables with potential export market. The primary factors in maintaining quality and extending the post-harvest life of fresh fruits and vegetables are harvesting at proper maturity, minimizing mechanical injury, using proper sanitation procedures and maintaining the optimum temperature and relative humidity during storage (Swati Barche and Kirad, 2010).

In onion, sprouting limits the storability of bulbs. At harvest, the bulbs are usually dormant. Depending on genotype and storage conditions, sprouting is initiated after a certain period of storage. In contrast, application of ethephon during bulb development in the field apparently reduced sprouting during storage (Thomas and Rankin, 1982). Exogenous ethylene proved to be a powerful inhibitor of sprouting in onion bulbs. The dormancy breaking effect of 1-MCP indicates a regulatory role of endogenous ethylene in bulb dormancy (Chope *et al.* 2007).

*Corresponding author's email: indunathan@gmail.com

Though there are many research and storage studies in onion with maleic hydrazide (MH) treatment, the aim of this study was to eliminate the hazardous effect of the banned chemical, MH. This study therefore, sought to determine the effect of pre harvest treatments on the bulb yield, physiological loss in weight, sprouting loss, pyruvic acid content and storage methods along with shelf life of onion bulbs.

Materials and Methods

The experiment was laid out in a randomized block design with thirteen treatments replicated thrice on a plot size of 3 x 2 m^2 with a spacing of 10 x 15 cm. The field layout and randomization of treatments were carried out as per the statistical methods given by Panse and Sukhatme (1985). The experimental field view of onion is shown in the Fig.1. The crop was raised during July-October, 2014 and the post-harvest quality and storage studies were carried out.

Cycocel, ethrel and kinetin were used individually and in combination with ridomil. The treatments combinations are given below;

Pre harvest treatments

T_1	Cycocel @ 200 ppm at 30 days (d) before harvest
T_2	Ethrel @ 150 ppm at 30 d before harvest
T_3	Kinetin @ 10 ppm at 30 d before harvest
T_4	Cycocel @ 200 ppm at 15 d before harvest
T_5	Ethrel @ 150 ppm at 15 d before harvest
T_6	Kinetin @ 10 ppm at 15 d before harvest
T_7	Cycocel @ 200 ppm + Ridomil @ 0.2% at 30 d before harvest

T_8 Ethrel @ 150 ppm + Ridomil @ 0.2% at 30 d before harvest

T_9 Kinetin @ 10 ppm + Ridomil @ 0.2% at 30 d before harvest

T_{10} Cycocel @ 200 ppm + Ridomil @ 0.2% at 15 d before harvest

T_{11} Ethrel @ 150 ppm + Ridomil @ 0.2% at 15 d before harvest

T_{12} Kinetin @ 10 ppm + Ridomil @ 0.2% at 15 d before harvest

T_{13} Control

Curing

The harvested onion bulbs were kept in the field for three days followed by curing under shade for two days (Fig. 2 and 2a). Curing of onion bulbs helped in reducing the post-harvest losses.

Storage

At the end of the curing period, a composite sample of five kg bulbs were stored in a low cost, ventilated storage structure for three months. A low cost, bottom ventilated bamboo structure with thatched roof was constructed for storing the aggregatum onion at Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore following the specifications given National Research Centre for Onion and Garlic (NRCOG) (Tripathi and Lawande, 2007). This was a single row storage structure constructed with bamboo rafters (Fig.3). Half split bamboos were used for floor, while the side walls were made of split bamboos. The pillars of whole bamboos were erected at five feet distance and the structure was positioned in north-south direction. Constant observations were recorded for analyzing the quality of the stored onion. Further details of the low cost bottom ventilated structure are given in Table 1.

Table 1. Dimensions of the ventilated storage structure

	Dimension (m)
Length	4.5
Width	1.2
Side height	1.5
Centre height	1.8
Bottom ventilation	0.3

Results and Discussion

Effect of pre harvest treatments on yield parameters

Observations such as number of bulbs/plant, bulb weight (g/plant) and estimated yield (t/ha) were recorded to assess the yield and quality of treated aggregatum onion. From Table 2, it is observed that the number of bulbs/plants ranged from 6.06 to 6.81 in the pre-treated aggregatum onion. This was recorded to be the highest T_7 (Cycocel @ 200 ppm + Ridomil @ 0.2% at 30 d before harvest), followed by T_6. The lowest values were obtained in T_{13} and control. The results showed that cycocel induced the growth of bubs/plant. The bulb weight ranged from 30.32 to 47.09 g/plant.

Table 2. Effect of pre harvest treatments on yield of onion cv. CO(On)5

Treatments	Number of bulbsplant^{-1}	Bulb weight (g/plant)	Yield (t/ha)
T_1	6.37	41.88	17.33
T_2	6.22	38.63	16.22
T_3	6.32	37.42	15.62
T_4	6.16	37.38	15.58
T_5	6.12	37.36	15.37
T_6	6.54	33.25	13.92
T_7	6.81	47.09	18.50
T_8	6.36	37.98	15.67
T_9	6.30	37.07	15.30
T_{10}	6.55	42.05	17.72
T_{11}	6.46	34.21	15.08
T_{12}	6.06	31.41	13.75
T_{13}	6.02	30.32	12.50
Mean	6.35	37.38	15.58
SEd	0.075	0.066	1.26
CD (0.05)	0.150	0.132	2.53

The bulb weight was induced by the preharvest treatment T_7 at 30 d before harvest, followed by plot treated with ethrel @ 150 ppm + ridomil @ 0.2% at 30 d before harvest (T_8). Control recorded the lowest bulb weight compared to the treated samples. The bulb weight recorded in the other growth regulator treatments namely, T_3, T_4, T_5 and T_{10} did not show any significant difference. These results brought out the role of cycocel in increasing the photosynthetic activity, translocation of photo assimilates to bulbs and roots, better conversion of photo assimilates from source to sink, ultimately leading to the highest weight of whole plant. Another reason could be the increased number of bulbs by reducing apical growth and early bulb formation as reported by Anjappa *et al.* (2001) and Maruthi *et al.* (2003a). Based on the yield recorded,the treat ment, 7 (Cycocel @ 200 ppm + Ridomil @ 0.2% at 30 d before harvest) showed the highest yield of 18.50 t/ha, followed by T8 (Ethrel @ 150 ppm + Ridomil @ 0.2% at 30 d before harvest) which recorded the yield of and 17.72 t/ha.

Among the growth regulator treated plots, the treatments T12 and T6 recorded the lowest yields of 13.75 and 13.92 t/ha, respectively. The bulb yield of control treatment (T13) was lower (12.50 t/ha) compared to the growth regulator treated aggregatum onion. Cycocel promoted yield attributing characters, which might be due to the complementary action on nucleic acid metabolism and protein synthesis (Vijayakumar and Khader, 1986; Das and Das, 1996). Among the different growth regulator treatments, the highest values of yield parameters in aggregatum onion was recorded in the treatment T7 (Cycocel @ 200 ppm + Ridomil @ 0.2% at 30 d before harvest) and the lowest was recorded in T12 (Kinetin @ 10 ppm + Ridomil @ 0.2% at 15 d before harvest) and control.

Curing studies

Curing is an important operation in the post-harvest technology of onion for reducing the losses of bulbs. Onions are considered suitable for storage when the neck is tight and the outer scales are dry and rustle when handled. Among the different methods of curing, bulbs with 2 cm neck length recorded the lowest physiological loss in weight and sprouting (Fig. 2 and 2a). The least physiological loss in weight may be attributed to the proper driage of the outer scales and tight neck, checking further escape of moisture and thus, reducing the weight loss during storage. Bulbs which were harvested at 120 d leaving 2 cm neck was found to be beneficial in several ways and these set of practices formed very important post-harvest step in onion (Anbukkarasi, 2010). The maximum sprouting loss was observed in control indicating the importance of neck length and curing under shade for storage of onion bulbs.

Storage studies

Fig.1. Experimental field view of onion crop

Fig. 2. Field curing under open condition

Fig. 2a. Curing under shade condition

At the end of curing period, a composite sample of five kg bulbs, were stored in a low cost ventilated storage for three months. The stored onion bulbs (Fig. 3) were evaluated interms of physiological loss in weight, sprouting, rotting, change in moisture content and pyruvic acid content at monthly intervals for 3 months. The quality results after 30 d of storage are given in Table 3. Among the different pre-harvest treatments, T_7 (Cycocel @ 200 ppm + Ridomil @ 0.2% at 30 d before harvest) recorded the lowest physiological loss, sprouting and rotting of 1.26, 0 and 0.38%, respectively. Also, T_7 recorded the highest retention values in moisture content of 90.12 % (w.b.) and pyruvic acid content (2.59 µmol g^{-1}). These values were followed by T_{10}. Among the treatments, T_{12} and control (T_{13}) recorded the lowest quality values during storage of onion bulbs in ventilated storage structure after one month compared to all other treatments.

The changes in quality values of stored onion bulbs after 2 months in ventilated storage are given in Table 3 and 3a. From Table 3, it was observed that the changes in quality values such as the physiological loss in weight, sprouting and rotting percentage were found to be increased with increase in storage period.

Fig.3. Low cost, bottom ventilated bamboo structure

Fig. 4. View of stored onion bulbs in ventilated storage structure

The moisture content and pyruvic acid contents were found to be decreasing during storage periods. The changes in quality values were found to be lower in T_7 compared to all other treatments.

The results indicated (Table 3) that the control (T13) recorded maximum physiological loss in weight of 16.27 per cent and the minimum value of

Table 3. Quality of onion bulbs cv. CO(On)5 during storage

Treatment	Physiological loss in weight (%)			Sprouting (%)			Rotting (%)		
	one month storage	Two months storage	Three months storage	one month storage	Two months storage	Three months storage	one month storage	Two months storage	Three months storage
T_1	1.54	4.92	8.57	0.00	0.37	0.77	0.43	0.62	0.79
T_2	1.57	6.35	12.20	0.00	0.41	0.95	0.97	1.19	1.52
T_3	1.81	6.97	12.96	0.00	0.56	1.03	0.99	1.25	1.62
T_4	2.22	4.26	7.04	0.01	0.31	0.71	0.44	0.59	0.74
T_5	2.41	5.13	9.42	0.02	0.35	0.88	0.97	1.11	1.40
T_6	2.65	5.92	10.79	0.00	0..40	0.94	1.00	1.21	1.58
T_7	1.26	3.14	5.42	0.00	0.23	0.58	0.38	0.42	0.59
T_8	1.74	4.76	8.97	0.02	0.31	0.79	0.87	1.05	1.35
T_9	2.30	5.51	9.49	0.02	0.33	0.87	0.96	1.18	1.50
T_{10}	1.34	5.98	10.43	0.00	0.43	0.85	0.65	0.69	0.89
T_{11}	2.54	7.01	13.08	0.05	0.43	1.01	0.97	1.15	1.59
T_{12}	2.67	7.04	13.33	0.05	0.44	1.09	1.12	1.29	1.69
T_{13}	3.23	9.26	16.27	0.07	3.95	8.53	1.86	2.11	2.67
Mean	2.10	5.86	10.61	0.01	0.62	1.46	0.89	1.06	1.38
SEd	0.041	0.044	0.048	0.026	0.098	0.121	0.061	0.053	0.061
CD (0.05)	0.083	0.092	0.095	0.053	0.238	0.241	0.120	0.115	0.120

5.42 per cent in T7 (spreading of bulbs in ventilation storage + Cycocel @ 200 ppm + Ridomil @ 0.2% at 30 d before harvest). Among the pretreated onion samples, T12 (Kinetin @ 10 ppm + Ridomil @ 0.2% at 15 days before harvest) recorded significantly higher physiological loss in the weight of onion bulbs (13.33%). This showed that the treatment T12 did not help in reducing the physiological loss in weight stored under ventilated storage structure. Pre-harvest spray of Cycocel @ 200 ppm + Ridomil @ 0.2% at 30 d before harvest was found to reduce the physiological loss in weight (Doreyappa and Krishnappa, 1986) and the reason might be due to the action of Ridomil @ 0.2% in preventing the pathogenic infection by post-harvest and field fungi.

Table 3a. Quality of onion bulbs cv. CO(On)5 during storage

Treatments	Moisture content (%)			Pyruvic acid (μmol g^{-1})		
	one month storage	Two months storage	Three months storage	one month storage	Two months storage	Three months storage
T_1	89.88	86.12	83.88	2.58	2.41	2.39
T_2	88.25	85.05	82.25	2.57	2.43	2.34
T_3	87.17	84.98	81.17	2.61	2.44	2.31
T_4	89.69	86.69	84.69	2.52	2.4	2.43
T_5	89.42	86.42	83.42	2.47	2.39	2.38
T_6	88.44	85.98	82.44	2.43	2.38	2.36
T_7	90.12	88.62	85.73	2.69	2.52	2.48
T_8	88.01	86.97	84.01	2.59	2.45	2.41
T_9	89.76	86.15	82.76	2.63	2.47	2.36
T_{10}	88.96	84.85	82.96	2.61	2.41	2.36
T_{11}	87.84	85.16	81.84	2.50	2.4	2.31
T_{12}	86.45	84.05	80.45	2.46	2.4	2.34
T_{13}	82.82	81.95	79.82	2.40	2.25	2.19
Mean	88.21	85.61	82.72	2.54	2.41	2.36
SEd	0.024	0.023	0.021	0.004	0.013	0.014
CD (0.05)	0.047	0.045	0.041	0.008	0.025	0.027

The higher sprouting (8.53 per cent) was exhibited in the treatment T_{13} and the least sprouting of 0.58 per cent was recorded in T_7. The treatment T_7 (Cycocel @ 200 ppm + Ridomil @ 0.2% at 30 d before harvest) controlled the sprouting of onion bulbs significantly compared to other pre treatments under ventilated storage conditions. Cycocel spray at 200 ppm was found to be comparatively more effective than other treatments. This could be attributed to the fact of reduced sprouting of onion bulbs as a consequence of cessation of the growth of leaf primordia with reduced protein synthesis and transaminase activity and respiration. The crop was harvested at 120 d after transplanting, judged by 50 per cent of the leaf showing yellowing, senescence and neck fall symptoms (Benkeblia *et al.,* 2002). Maximum rotting (2.67 per cent) and the least rotting (0.59 per cent) were recorded in T_{13} and T_7 (Spreading of bulbs in ventilation storage), respectively. Among the treatments, the maximum total loss of 18.41 per cent was exhibited in the treatment T_{13} (control) and the minimum value (6.58 per cent) was registered in the treatment T_7 (spreading of bulbs in ventilation storage). The rotting was mainly due to moisture accumulation and this effect was completely reduced due to the action of T_7 pre-treatment given to onion bulbs. The controlled samples absorbed moisture easily and the rotting effect was noticed more significantly.

From the stored onion bulbs, it was further observed that there was a reduction in moisture content during storage. The highest moisture content of 85.73 per cent was recorded in T_7 (spreading of bulbs in ventilation storage + 30 d after storage) and the lowest value of moisture content was recorded in T_{13} (79.82 per cent) by spreading of bulbs in ventilation storage. In the present investigation, pre-harvest sprayed bulbs stored in low cost bottom ventilated structure (Fig. 4) showed reduced moisture content. This might be due to low metabolic activity of stored pre-harvest growth inhibitors and retardants treated bulbs. But under untreated onion storage condition, maximum percentage of moisture loss occurred as reported by Vijayakumar (1983) in the conventional structures (pattarai). This might be due to the varying temperature that prevailed in the structures during storage. Ward, (1976) noticed an increased desiccation losses with increased temperature. So, comparatively, the highest temperature that prevailed in the conventional structure might be the cause for the lowest moisture content recorded.

Among the different treatments, higher pyruvic acid content of 2.48 µmol g^{-1} was recorded in T_7 (spreading of bulbs in ventilation storage) and lower pyruvic acid content was recorded in T_{13} (spreading of bulbs in room temperature (control) with a value of 2.19 µmol g^{-1}. The overall results showed that the pre-harvest foliar spray of Cycocel @ 200 ppm + Ridomil @ 0.2% at 30 d before harvest would be beneficial to improve the yield and quality and to minimize the post-harvest loss in onion.

The harvested onion bulbs could be given curing treatment of 2 cm neck length, which was very effective in the control of sprouting and improvement of shelf life. The cured onion bulbs could be stored up to six months under low cost bottom ventilated storage structure without much deterioration in the biochemical constituents and nutritional qualities. Thus, it can be concluded that the application of cycocel @ 200 ppm + ridomil @ 0.2% at 30 d before harvest and cured with 2 cm neck length and storing of bulbs in low cost bottom ventilated storage structure increased the shelf life of aggregatum onion bulbs during the study period of three months.

References

Anbukkarasi, V. 2010. Studies on pre and post-harvest treatments for extending shelf life in onion (*Allium cepa* L. var aggregatum Don.) cv. CO(On)5. Ph.D Thesis, Tamil Nadu Agricultural University, Coimbatore.

Anjappa, M., K.S. Krishnappa, N.C.N. Gowda and N.S. Reddy. 2001. Effect of different growth substances on fresh weight, dry weight of plant and quality of tubers of potato crop raised from TPS transplants. *Plant Growth Regulator Abstr*., **27**(4): 330.

Benkeblia, N., P. Varoquaux, N. Shiomi and H. Sakai. 2002. Storage Technology of onion bulbs cv. Rouge Amposta: Effects of Irradiation, maleic hydrazide and carbamate isopropyl, n-phenyl (CIP) on respiration rate and carbohydrates. *International J. Food Sci & Tech., **37**(2):* 169-175.

Das, B.C and T.K. Das. 1996. Studies on the response of GA_3, NAA and ethrel on the vegetative growth of yield of pumpkin (*Cucurbita moschata* Port.). *Orissa J. Hort*., **24**: 74-78.

Doreyappa G.I.N. and K.S. Krishnappa. 1986. Effect of pre-harvest foliar spray of maleic hydrazide on storage behaviour of potato stored at room temperature. Potato Journal, 13 (3&4): 6. Dormancy and sprout suppression. *Stewart Post-harvest Rev.,* **4**: 1–7.

Chope G.A, L.A. Terry and P.J. White. 2007. The effect of 1-methylcyclopropene (1-MCP) on the physical and biochemical characteristics of onion cv. SS1 bulbs during storage. *Postharvest Biology and Technology,* **44**:131–140.

Maruthi, M., M.C. Gowda and A.P.M. Gowda. 2003a. Influence of growth regulators on yield and quality of ginger cv. Himachal Pradesh at different stages. In: Natl. Sem. New Prospective in Spices, Medicinal and Aromatic Plants, Goa, pp: 349-351.

National Horticultural Board. 2014-15. http://nhb.gov.in/area%20_production.html.

NHRDF. 2009. National Horticultural Research and Development Foundation, *Nasik-Newsletter*, **XXIX** (4).

Panse, V.G. and P.V. Sukhatme. 1985. The statistical methods for agricultural workers, ICAR Publications, New Delhi, pp:75-78.

Swati Barche and K.S.Kirad. 2010. Post harvest Handling of Fruits, Vegetables and Flowers. Jain Brothers, New Delhi, pp: 1-17.

Thomas T.H, Rankin W.E.F. 1982. Effect of ethephon on bulbing, bull-necking, yield and sprouting during storage of two onion cultivars (*Allium cepa* L.) *J. Hort. Sci*., **57**:465–467.

Tripathi, P.C. and K.E. Lawande. 2007. Effect of sprout suppressant and storage environment on storage losses and post-cold storage behaviour of onion. *Indian J. Hort.,* **64**(3)*:* 340-344.

Vijayakumar, R.M. 1983. Studies on post-harvest technology in small onion (*Allium cepa* L. var. *aggregatum* Don.). M.Sc (Thesis), Department of Vegetable Crops, Tamil Nadu Agricultural University, Coimbatore.

Vijayakumar, M. and J. B. M. Md. A. Khader. 1986. Effect of ethrel and CCC on certain growth and yield attributes of cassava. *South Indian Hort*., **34**(4): 228-235.

Ward, C.M. 1976. The influence of temperature on weight loss from stored onion bulbs due to desiccation, respiration and sprouting. *Ann. Appl. Biol.,* **83**(1)*:* 149-155.

Received after revision : February 29, 2016 ; Accepted : March 18, 2016