Plant Archives Vol. 17 No. 2, 2017 pp. 1023-1027 ***ISSN 0972-5210***

BIOCHEMICAL CHANGES IN ONION DURING AMBIENT STORAGE AS AFFECTED BY PREHARVEST TREATMENTS

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Abstract

An experiment was conducted at the University Department of Horticulture, Dr. PDKV, Akola (M.S., India) during the academic year 2012-2013 to study the effect of pre-harvest treatments on biochemical changes in onion during ambient storage in Completely Randomized Block Design with 11 treatments *viz*., $\mathbf{T_1}$ – Carbendazim 1000 ppm + Maleic hydrazide 2000 ppm, $\mathbf{T_2}$ – Carbendazim 1000 ppm + Maleic hydrazide 2500 ppm, $\mathbf{T_3}$ – Benomyl1000 ppm + Maleic hydrazide 2000 ppm, $\mathbf{T_4}$– Benomyl 1000 ppm + Maleic hydrazide 2500 ppm, $\mathbf{T_5}$ – Carbendazim 1000 ppm +Streptocycline 200 ppm, $\mathbf{T_6}$ – Carbendazim 1000 ppm + Streptocycline 500 ppm, $\mathbf{T_7}$ – Carbendazim 1000 ppm + Maleic hydrazide 2000 ppm +Streptocycline200 ppm, $\mathbf{T_8}$– Carbendazim 1000 ppm+ Maleic hydrazide 2000 ppm+ Streptocycline500 ppm, $\mathbf{T_9}$– Carbendazim 1000 ppm + Maleic hydrazide 2500 ppm +Streptocycline200 ppm, $\mathbf{T_{10}}$- Carbendazim 1000 ppm + Maleic hydrazide 2500 ppm +Streptocycline500 ppm and $\mathbf{T_{11}}$- Control replicated thrice. The treatments were imposed 2 weeks before harvesting of onion bulbs by spraying uniformly the plants as per the treatments and the bulbs after harvesting and curing used for storage studies. The results revealed that pre-harvest spray showed significant influence on chemical parameters of onion bulbs and among the pre-harvest spray, Carbendazim 1000 ppm + Maleic Hydrazide 2500 ppm +Streptocycline 200 ppm resulted in maximum ascorbic acid content, TSS, non-reducing sugar, total sugar and dry matter content, whereas, maximum reducing sugar was noted with Carbendazim 1000 ppm + Maleic hydrazide 2000 ppm + Streptocycline 200 ppm.

Key words : Onion, pre-harvest treatment, storage, biochemical changes.

Introduction

Onion is one of the potential foreign exchange earners and India stands first in production sharing eight per cent of the world production. It is valued for its distinct pungent flavour and is an essential ingredient for the cuisine of many regions. Onion is the queen of kitchen and it is preferred mainly because of its green leaves; immature bulbs which are often chosen for salad. The bulbs are used in soups, sauces, condiments, spices, and also in medicines. It plays an important role in preventing heart diseases and other ailments.Onion is a valuable ingredient in human diet due to its contents of sugars, vitamins and minerals.

There are several growth regulators and chemicals which are used for improving the storage life of onion bulbs. Pre-harvest sprays have been widely applied without impairing the keeping quality of onion. Among the growth substances/chemicals, maleic hydrazide, ethrel, cycocel, carbendazim, benomyl, streptocycline treatments as pre-harvest foliar application have gained prominence. These compounds greatly facilitate the maintenance of quality of onion bulbs on storage with respect to inhibition of sprouting, rooting and reduction in the physiological loss in weight. Therefore, an investigation on effect of pre-harvest spray of chemicals and growth regulators was conceived and executed with an objective to know the biochemical changes during storage of onion bulbs under ambient storage.

Materials and Methods

The experiment was conducted at the Main Garden and Post Harvest Technology and Analytical Laboratory, University Department of Horticulture, Dr. PDKV, Akola (M.S.) during the academic year 2012-2013. The experiment was laid out in completely randomized block design with 11 treatments *viz*., $\mathbf{T_1}$ – Carbendazim 1000 ppm + Maleic hydrazide 2000 ppm, $\mathbf{T_2}$ – Carbendazim 1000 ppm + Maleic hydrazide 2500 ppm, $\mathbf{T_3}$– Benomyl

1000 ppm + Maleic hydrazide 2000 ppm, T_4– Benomyl 1000 ppm + Maleic hydrazide 2500 ppm, T_5 – Carbendazim 1000 ppm +Streptocycline 200 ppm, T_6 – Carbendazim 1000 ppm +Streptocycline 500 ppm, T_7 – Carbendazim 1000 ppm + Maleic hydrazide 2000 ppm + Streptocycline 200 ppm, T_8– Carbendazim 1000 ppm+ Maleic hydrazide 2000 ppm+ Streptocycline 500 ppm, T_9–Carbendazim 1000 ppm + Maleic hydrazide 2500 ppm +Streptocycline 200 ppm, T_{10}- Carbendazim 1000 ppm + Maleic hydrazide 2500 ppm + Streptocycline 500 ppm and T_{11}- Control replicated thrice. The treatments were imposed 2 weeks before harvesting of onion bulbs by spraying uniformly the plants as per the treatments. The crop was harvested at maturity *i.e.* 140 days after transplantingwhen 50 per cent of the plants showed drying of leaves and neck fall. The plants were pulled along with leaves and cured for 3 days in the field. Then the foliage was cut with sharp knife leaving 1.5-2 cm top portion above the bulb. The cured onion bulbs were sorted out and 5 kg healthy bulbs from each treatment kept in laboratory for storage studies.

The observations on chemical characteristics of onion bulbs were recorded at an interval of 20 days upto 120 days of storage and the data analyzed statistically by the method suggested by Panse and Sukhatme (1967). Total soluble solid was determined with the help of hand refractometer and ascorbic acid content was determined by titration method using 2,6- dichlorophenol indophenol dye. Sugars (reducing, non-reducing and total) were determined by Dinitro salicylic acid method (Miller, 1972)

Table 1 : Effect of different pre-harvest spray on total soluble solid and ascorbic acid content of onion bulbs during ambient storage.

Treatments	Total soluble solid (^{0}B)						Ascorbic acid (mg/100 g)					
	Days after storage						Days after storage					
	20	40	60	80	100	120	20	40	60	80	100	120
T_1 - Carbendazim 1000 ppm + Maleic hydrazide 2000ppm	10.81	10.86	11.02	12.02	12.13	12.7	11.98	11.80	10.70	9.99	8.88	7.55
T_2 - Carbendazim 1000 ppm + Maleic hydrazide 2500ppm	11.40	11.62	12.03	12.15	12.38	12.84	12.56	12.36	11.78	11.07	9.40	8.70
T_3 - Benomyl1000 ppm + Maleic hydrazide 2000ppm	10.66	10.78	11.48	11.65	11.72	11.80	12.05	11.78	10.98	9.66	8.30	7.07
T_4- Benomyl 1000 ppm + Maleic hydrazide 2500ppm	10.96	11.15	11.44	11.58	11.67	11.77	12.32	11.90	10.72	9.48	8.21	7.18
T_5- Carbendazim 1000 ppm + Streptocycline 200 ppm	10.48	10.70	10.98	11.52	11.87	12.00	11.60	11.02	10.38	8.92	7.27	6.24
T_6- Carbendazim 1000 ppm + Streptocycline 500 ppm	10.56	10.89	11.14	11.60	11.90	12.05	11.80	11.45	10.48	8.97	7.80	6.41
T_7 - Carbendazim 1000 ppm + Maleic hydrazide 2000ppm +Streptocycline 200 ppm	11.36	10.57	11.96	12.00	12.32	12.52	12.42	12.16	11.54	9.91	8.35	7.07
T_8- Carbendazim 1000 ppm + Maleic hydrazide 2000ppm + Streptocycline 500 ppm	11.34	10.59	11.33	12.10	12.22	12.77	11.39	12.19	11.57	10.10	8.62	7.31
T_9- Carbendazim 1000 ppm + Maleic hydrazide 2500ppm + Streptocycline200 ppm	11.30	11.50	11.92	12.12	12.27	12.80	12.48	12.22	11.68	11.00	9.20	8.76
T_{10}- Carbendazim 1000 ppm + Maleic hydrazide 2500ppm + Streptocycline500 ppm	11.43	11.65	12.09	12.22	12.78	13.10	12.60	12.48	12.28	11.20	10.00	8.65
T_{11}- Control	10.15	10.49	10.83	11.45	11.85	11.98	10.35	9.87	9.52	8.80	7.14	6.10
SE(m) ±	0.05	0.03	0.20	0.07	0.04	0.03	0.11	0.05	0.05	0.03	0.02	0.03
CD at 5%	0.16	0.11	0.59	0.23	0.12	0.09	0.33	0.16	0.16	0.09	0.08	0.10

and dry matter content of bulbs was recorded by using the formula-

$$\text{Per cent dry matter} = \frac{\text{Dry weight}}{\text{Fresh weight}} \times 100$$

Results and Discussion

Total soluble solids

It is evident from the data presented in table 1 that, significant differenceswere observed between the different treatments of pre-harvest sprayat all the stages of storage. Onion sprayed with the treatment T_{10} (Carbendazim 1000 ppm + Maleic hydrazide 2500 ppm + Streptocycline 500 ppm) recorded significantly maximum TSS at all the stages of storage (11.43, 11.65, 12.09, 12.22, 12.78, 13.10 ^{0}brix, respectively) followed by T_2 *i.e.* Carbendazim 1000 ppm + Maleic hydrazide 2500 ppm (11.40, 11.62, 12.03, 12.15, 12.38, 12.84^{0}brix, respectively), whereas, significantly minimum TSS was noticed with the control treatment *i.e.* T_{11} (10.15, 10.49, 10.83, 11.45^{0}brix) at 20, 40, 60, 80 days after storage, respectively. However, at 100th and 120th day of storage minimum TSS was recorded in the treatment T_4 *i.e.* Benomyl 1000 ppm + Maleic hydrazide 2500 ppm (11.67 and 11.77^{0}brix, respectively). The maximum TSS content in the treatment of pre harvest spray of Carbendazim 1000 ppm + Maleic hydrazide 2500 ppm + Streptocycline 500 ppm may be due to accumulation of more carbon dioxide and low oxygen inside the bulbs and its suicidal effects on respiration which ultimately reduces the respiration rate, thereby reducing the losses of TSS (Mahadevswamy, 1984) or the increase in TSS content might be due to faster

Table 2 : Effect of different pre-harvest sprays on reducing and non-reducing sugarcontent of onion bulbs during ambient storage.

Treatments	Reducing sugar (%)						Non-reducing sugar (%)					
	Days after storage						Days after storage					
	20	40	60	80	100	120	20	40	60	80	100	120
T_1 - Carbendazim 1000 ppm + Maleic hydrazide 2000ppm	3.96	3.88	3.65	3.48	3.27	2.95	2.55	3.03	3.64	4.29	4.75	5.36
T_2 - Carbendazim 1000 ppm + Maleic hydrazide 2500ppm	3.85	3.70	3.57	3.46	3.25	2.97	2.75	3.29	3.81	4.33	4.92	5.39
T_3 - Benomyl 1000 ppm + Maleic hydrazide 2000ppm	3.97	3.81	3.68	3.45	3.28	3.02	2.42	2.97	3.49	4.16	4.60	5.27
T_4- Benomyl 1000 ppm + Maleic hydrazide 2500ppm	3.94	3.78	3.64	3.38	3.18	2.99	2.58	3.13	3.66	4.30	4.75	5.38
T_5- Carbendazim 1000 ppm + Streptocycline 200 ppm	3.90	3.77	3.60	3.40	3.26	2.96	2.39	2.87	3.43	3.67	3.87	4.20
T_6- Carbendazim 1000 ppm + Streptocycline 500 ppm	3.91	3.85	3.71	3.48	3.20	2.98	2.41	2.86	3.40	3.64	4.09	4.45
T_7 - Carbendazim 1000 ppm + Maleic hydrazide 2000ppm + Streptocycline 200 ppm	4.02	3.95	3.76	3.65	3.30	3.10	2.46	2.92	3.50	4.04	4.71	5.22
T_8- Carbendazim 1000 ppm + Maleic hydrazide 2000ppm + Streptocycline 500 ppm	3.92	3.800	3.72	3.62	3.32	3.21	2.60	3.11	3.59	4.12	4.73	5.12
T_9- Carbendazim 1000 ppm + Maleic hydrazide 2500ppm + Streptocycline 200 ppm	3.98	3.89	3.72	3.64	3.28	3.12	2.58	3.06	3.62	3.85	4.81	5.23
T_{10}- Carbendazim 1000 ppm + Maleic hydrazide 2500ppm + Streptocycline 500 ppm	3.86	3.71	3.59	3.44	3.18	2.98	2.77	3.31	3.82	4.40	5.03	5.41
T_{11}- Control	3.70	3.58	3.42	3.35	3.10	2.97	2.42	2.93	3.48	3.63	3.92	4.12
SE(m) ±	0.03	0.04	0.04	0.05	-	-	0.06	0.05	0.06	0.06	0.06	0.07
CD at 5%	0.11	0.14	0.14	0.16	0.18	0.17	0.18	0.17	0.19	0.19	0.19	0.21

Table 3 : Effect of different pre-harvest sprays on total sugar and dry matter content of onion bulbs during ambient storage.

Treatments	Total sugar (%)						Dry matter (%)					
	Days after storage						Days after storage					
	20	40	60	80	100	120	20	40	60	80	100	120
T_1 - Carbendazim 1000 ppm + Maleic hydrazide 2000ppm	6.65	7.07	7.49	8.00	8.28	8.60	11.25	11.94	12.28	12.76	13.03	13.65
T_2 - Carbendazim 1000 ppm + Maleic hydrazide 2500ppm	6.75	7.17	7.59	8.02	8.43	8.65	11.62	12.32	13.05	13.23	13.45	14.10
T_3 - Benomyl 1000 ppm + Maleic hydrazide 2000ppm	6.52	6.94	7.36	7.83	8.13	8.57	11.08	11.69	12.19	12.68	12.97	13.33
T_4- Benomyl 1000 ppm + Maleic hydrazide 2500ppm	6.66	7.08	7.50	7.91	8.18	8.66	11.28	11.89	12.59	12.78	13.05	13.62
T_5- Carbendazim 1000 ppm + Streptocycline 200 ppm	6.42	6.80	7.22	7.27	7.34	7.39	10.75	11.52	11.85	12.19	12.43	12.95
T_6- Carbendazim 1000 ppm + Streptocycline 500 ppm	6.45	6.87	7.29	7.32	7.51	7.67	10.79	11.68	12.00	12.27	12.61	13.18
T_7 - Carbendazim 1000 ppm + Maleic hydrazide 2000ppm + Streptocycline 200 ppm	6.61	7.03	7.45	7.91	8.26	8.60	11.31	11.72	12.02	12.46	12.99	13.12
T_8- Carbendazim 1000 ppm + Maleic hydrazide 2000ppm + Streptocycline 500 ppm	6.66	7.08	7.50	7.96	8.30	8.60	11.44	11.98	12.29	12.80	13.07	13.68
T_9- Carbendazim 1000 ppm + Maleic hydrazide 2500ppm + Streptocycline 200 ppm	6.70	7.12	7.54	7.70	8.35	8.63	11.53	12.25	12.98	13.14	13.40	13.87
T_{10}- Carbendazim 1000 ppm + Maleic hydrazide 2500ppm + Streptocycline 500 ppm	6.78	7.20	7.62	8.08	8.48	8.68	11.70	12.37	13.12	13.29	13.52	14.14
T_{11}- Control	6.25	6.67	7.09	7.18	7.23	7.31	10.15	10.65	11.19	11.78	12.04	12.07
SE(m) ±	0.02	0.01	0.01	0.01	0.01	0.01	0.13	0.09	0.06	0.03	0.03	0.03
CD at 5%	0.06	0.04	0.05	0.04	0.05	0.04	0.39	0.27	0.17	0.10	0.09	0.10

conversion of insoluble sugars into soluble forms and least utilization of organic acids. The results are in conformity with the findings of Aoyagi *et al*. (1997) in onion. Anbukkarasi (2010) also reported that, the pre harvest spray of maleic hydrazide @ 2000 ppm + Carbendazim @ 1000 ppm registered the improved quality parameters like TSS, content, total sugar and reducing sugar in an increasing trend with the advancement of storage period of onion.

Ascorbic acid

A critical appraisal of data presented in table 1 showed that, as the storage period extends, the decreasing trend of the ascorbic acid was found. As far as the individual treatment effect was concerned, the maximum ascorbic acid was found in $\mathbf{T_{10}}$ treatment at 20, 40, 60, 80 and 100 days after storage (12.60, 12.48, 12.28, 11.20 and 10.00 mg/100 g, respectively) and it was followed by the treatment $\mathbf{T_2}$ (12.56, 12.36, 11.78, 11.07 and 9.40 mg/100 g, respectively), while, significantly minimum ascorbic acid was recorded in control *i.e.* $\mathbf{T_{11}}$ (10.35, 9.87, 9.52, 8.80 and 7.14 mg/100 g, respectively). However, at 120th day of storage maximum ascorbic acid was found in $\mathbf{T_9}$ (8.76 mg/100g) followed by $\mathbf{T_2}$ (8.70mg/ 100g) and $\mathbf{T_{10}}$ (8.65mg/100g) and minimum ascorbic acid was observed in $\mathbf{T_{11}}$ (6.10 mg/100 g). There was gradual decrease in ascorbic acid content in all the treatments with the advancement of storage period which may be due to oxidative destruction of ascorbic acid in the presence of molecular oxygen by ascorbic acid oxidase enzymes. Deceasing trend of ascorbic acid with increasing storage period up to three months was also reported by Anbukkarasi (2010) in onion.

Reducing sugar (%)

The data from table 2 indicated that, there was no much variation in the reducing sugar content irrespective of the treatments; however, slight decrease in reducing sugars content was noticed with advancement of storage period. At 20th,40th, 60th and 80thday of storage the highest reducing sugar was found in $\mathbf{T_7}$ treatment *i.e.* Carbendazim 1000 ppm + Maleic hydrazide 2000 ppm + Streptocycline 200 ppm (4.02, 3.95, 3.76 and 3.65%, respectively), whereas, significantly minimum reducing sugar was recorded in $\mathbf{T_{11}}$ (3.70, 3.58, 3.42 and 3.35%, respectively). However, at the end of storage period *i.e.* at 100th and 120th day of storage the non-significant differenceswere observed. There was a gradual decrease in reducing sugar content in all the treatments with advancement of storage period which may be due to the utilization of reducing sugars like glucose and fructose for respiration and sprouting during storage. These results are in close agreement with the findings of Singh and Dhankar (1992), Aoyogi*et al*. (1997) and Anbukkarasi (2010) in onion.

Non-reducing sugar

The data pertaining to the changes occurred in non-reducing sugar content of onion during storage is presented in table 2, which showed that significantly highest non-reducing sugar recorded at 20, 40, 60, 80, 100 and 120 days after storage was noted with the treatment T_{10} (2.77, 3.31, 3.82, 4.40, 5.03 and 5.41 %, respectively) followed by $\mathbf{T_2}$ (2.75, 3.29, 3.81, 4.33, 4.92 and 5.39%, respectively). The maximum per cent of non-reducing sugar due to pre harvest spray of Carbendazim 1000 ppm + Maleic hydrazide 2500 ppm +Streptocycline500 ppm ($\mathbf{T_{10}}$) might be due to less consumption of sugars in the process of respiration and minimum breakdown of non reducing sugar into reducing sugar, thereby non reducing sugar content of the onion bulbsmight have increased (Mahadevswamy, 1984).

Total sugar

The data presented in table 3 revealed that, total sugar content of onion increases with the advancement of storage period. At all the stages of storage, the treatment $\mathbf{T_{10}}$ registered significantly maximum total sugar content of onion bulbs (6.78, 7.20, 7.62, 8.08, 8.48 and 8.68%, respectively) which was followed by the treatment T_2 (6.75, 7.17, 7.59, 8.02, 8.43 and 8.65 %, respectively), whereas, significantly minimum total sugar was recorded in the control *i.e.* $\mathbf{T_{11}}$ (6.25, 6.67, 7.09, 7.18, 7.23 and 7.31%, respectively). The maximum content of total sugars in these treatments is positively correlated with the ratio of sucrose to monosaccharide and also with keeping quality of bulbs during storage. Application of MH helps in increasing the ratio of sucrose to monosaccharide's there by results in maximum total sugar content of the bulb as reported by Kukanoor (2005) in onion and Nilima *et al*. (2014) in spider lily.

Dry matter

The data from table 3indicated that, per cent dry matter increased with the advancement of storage period. Different pre-harvest treatment had a significant influence on dry matter content of onion bulbs throughout the storage period. Significantly maximum dry matter content (11.70, 12.37, 13.12, 13.29, 13.52 and 14.14%, respectively) was noticedwith the treatment $\mathbf{T_{10}}$ and it was followed by the treatment $\mathbf{T_2}$ (11.62, 12.32, 13.05, 13.23, 13.45 and 14.10%, respectively), however, significantly minimum dry matter was recorded with the untreated onion bulbs *i.e.* $\mathbf{T_{11}}$ (10.15, 10.65, 11.19, 11.78, 12.04 and 12.07%, respectively) at 20, 40, 60,80,100 and 120 days after storage. The maximum dry matter content in the treatment $\mathbf{T_{10}}$ during storage period might be due to the increase in chemical constituents and decrease in moisture content of the bulbs. The pre-harvest spray of Carbendazim 1000 ppm + Maleic hydrazide 2500 ppm + Streptocycline 200 ppm resulted in reduction of moisture content of bulbs and thereby the hydrolysis of sugars might have stopped and ultimately resulted in highest dry matter content due to accumulation of more sugar. Similar results have been reported in onion by Mahadevswamy (1984) and Kukanoor (2005) in onion.

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