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Research Article

EFFECT OF PRE-HARVEST TREATMENT WITH CHEMICALS ON YIELD AND STORAGE OF ONION *CV.* N-2-4-1

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Abstract: Effect of pre-harvest treatments with chemicals on yield,and storage of onion (*Allium cepa* L.) The experiment was laid out in Randomized Block Design with three replications along with ten treatments. The pre-harvest spray comprises of Streptocycline 200 Ppm (1.2 g/lit), Copper oxychloride 0.25 % (2.5 g/lit), Streptocycline 200 Ppm + COC 0.25 % (1.2 + 2.5 g/lit), Cycocel 500 Ppm (1 ml/lit), Cycocel 1000 Ppm (2 ml/lit), Carbendazim 1000 Ppm (1 g/lit), Carbendazim 2000 Ppm (2 g/lit), Mancozeb 0.25 % (2.5 g/lit), Azoxystrobin 1000 Ppm (2 ml/lit) and control (farmer practice). Pre harvest spray was given at just start of neck fall before harvesting. The observations on equatorial diameter (cm), polar diameter (cm), average weight of bulb (g), % of 'A' grade bulbs, % of 'B' grade bulbs, % of 'C' grade bulbs, % of doubles, % of premature bolters, total bulb yield (t/ha) recorded at the time of harvesting of bulbs and storage losses including, rotting, sprouting, plw, and total losses were recorded during storage at 30, 60, 90, 120, 150 and 180 days after storage.

Keywords: *Pre-harvest, Neckfall, Bolting, Pollar diameter, Physiological Loss*

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Introduction

The onion (*Allium cepa* L.), one of the oldest bulb crops known to humankind, is an important vegetable crop and is consumed all over the world. Onion belongs to the family Alliaceae, genus Allium and species cepa.

One of the most significant commercial vegetable crops in India, it is thought to have its origins in Central Asia. Green onions, immature bulbs, and mature bulbs are either consumed raw or cooked as vegetables. The allyl-propyl disulphide, a volatile substance, is what gives onions their pungent flavour. Onion is used in a variety of traditional medicines, and a new study found that it may be helpful in reducing heart disease and other illnesses. The vitamin B content of onions is high. Using onions as a diuretic to bumps, boils, and sores. It restores the feeling of heat. Around 501 g of vitamin A, 0.03 mg of thiamine, 0.04 mg of riboflavin, 0.02 mg of niacin, and 9 mg are present in one hundred grammes of raw onion bulb. All around the world, but particularly in India, China, Pakistan, the Netherlands, Bangladesh, and Australia, onions are widely cultivated. After China, India is second in the world in terms of area and production, and third in terms of export. With a total production of 116.30 million tonnes, it is farmed on an area of 0.95 million hectares in India. In India and the state of Maharashtra, onions are mostly farmed in the winter months during the three seasons of *kharif* (rainy), late *kharif* (rangada), and *rabi* (winter).

As a result, the storage of onion bulbs has turned into a major issue in tropical nations like India. Sprouting, decaying, and post-harvest waste are major problems. According to reports, annual storage losses in India ranged from 40 to 60 percent [1] and exceeded 40 percent [2]. According to estimates, desiccation, rotting, and sprouting in storage cause 40 to 50 percent of the 41 lakh tonnes of onions produced—worth more than Rs. 600 corers-to be wasted. Due to excessive storage losses, there is a shortage of onions, which raises the price. Bearing this in mind, countries that grow onions are working to find solutions to these post-harvest issues and slow the rate of degradation. Widespread pre- and post-harvest treatments have been used without compromising onion quality for storage. It made it much easier to maintain high-quality onion bulbs in storage by preventing sprouting, rotting, and a rise in plw.

As a result, even though a lot of effort has been done in this area, there is still room for significant advancement since onions are perishable goods with high storage loss rates. The onion's storage life has been shortened as a result of current practise. As a result, during the seasonal glut, farmers are compelled to sell their produce as soon as it is harvested at extremely low rates. They will frequently struggle to sell the produce because keeping it would increase losses from rotting, sprouting, weight loss, *etc.* Many times, farmers have been forced into debt traps and committed suicide because they were unable to recoup their transportation expenses from the sale of their produce [3-5].

Material and methods

The present investigation entitled effect of pre-harvest treatments with chemicals on yield, and storage of onion (*Allium cepa* L.) was carried out at, Scheme for Research on Onion Storage, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth Rahuri, during *rabi* season. The materials used and methods adopted during investigation were mentioned here under.

Materials

Experimental site and location

The field experiment was conducted in the farm of Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar; during *rabi* season Geographically, central campus of MPKV, Rahuri is situated between 19°47' to 19°57' North latitude & 74°19' to 74°42' East longitude with elevation of 525 m above the mean sea level.

Soil

The topography of the field was fairly leveled flat beds were prepared for onion transplanting, soil was medium black having moderate in moisture retention capacity.

Climatic condition

Climatically, this area is in semi-arid, sub-tropical zone, with annual rainfall varying from 307 mm to 619 mm. The average rainfall is 475 mm.

Most of the rainfall is received through South-West monsoon. The annual mean maximum and minimum temperature are 34.5°C and 18.3°C, respectively.

Procurement of experimental material

Seedling of onion *Cv.* N-2-4-1 was obtained from Onion Breeder, Scheme for Research on Onion Storage, Department of Horticulture, MPKV, Rahuri.

Methods

Experimental details

The experiment was laid out in Randomized Block Design (RBD) with three replications having ten treatments including one control.

The details of present investigation conducted during the year Variety :N-2-4-1

Season : *Rabi*

Design : Randomized Block Design (RBD)

Treatments : Ten (9 treatments + 1 control)

Replication : Three

Plot size : 3 m x 2 m (Flat bed)

Spacing : 15 cm x 10 cm

Sample size of : 10 kg bulb of each treatment bulb for storage

Storage period : 6 months

Observation taken : Monthly interval

Time of application : Pre-harvest spray at just the start of neck fall

Treatment Details -

Sr. No.	Treatment	Treatment details
1	T_1	Streptocycline 200 Ppm
2	T_2	Copper oxychloride 0.25%
3	T_3	Streptocycline 200 Ppm + Copper oxychloride 0.25%
4	T_4	Cycocel 500 Ppm
5	T_5	Cycocel 1000 Ppm
6	T_6	Carbendazim 1000 Ppm
7	T_7	Carbendazim 2000 Ppm
8	T_8	Mancozeb 0.25%
9	T_9	Azoxystrobin 1000 Ppm
10	T_{10}	Control (Farmer practice)

The solutions of chemicals were prepared by dissolving the required quantities of chemicals in known volume of water to obtain required concentrations.

The solution was sprayed uniformly with a Knapsack sprayer to onion foliage accordance with the experimental treatments. Pre harvest spray given at just the start of neck fall.

Cultural practices

Seed was sown in raised beds for preparation of seedlings in nursery. Main field was prepared to fine tilth through tillage operations and flat beds of 3 m x 2 m were made. Before transplanting on experimental site fertilizers were as FYM 20 t/ha and chemical fertilizers 50 kg N, 50 kg P_2O_5 and 50 kg K_2O per hectare at the time of transplanting as basal dose. After 30 days of transplanting 50 kg N per hectare applied as top dress dose of fertilizer. Seedlings treated with bavistin 0.1 % @ 1 g/litre at the time of transplanting. Transplanting was done on 15 cm X 10 cm spacing. Immediately after transplanting, irrigation was given. Timely intercultural operations were followed as recommended for the crop like weeding, plant protection sprays and irrigation schedule.

Pre harvest Treatment

The required quantity of solution of chemicals was prepared by dissolving the required quantities of chemicals in known volume of water to obtain required concentrations. The solutions were sprayed uniformly with a knapsack sprayer to onion foliage and pre-harvest spray given at just the start of neck fall.

Harvesting

For harvesting of onion bulbs the proper time is when 50 percent of plants showed drying and falling of their necks, leaves turned yellow, becoming dry at the tops. The plants were pulled along with leaves and kept for 3-4 days in the field for curing. Then the foliage was cut with sharp clean knives leaving 2.5 cm top above the bulb.

Storage

The cured onion bulbs were sorted out and 10 kg healthy bulbs from each treatment were kept for storage studies.

Observations recorded

Yield and quality attributes

Equatorial diameter of bulb (cm)

Equatorial diameter of the bulbs is the diameter of the bulb when it is kept up right in natural position. It is measured by Vernier Caliper. The five randomly selected bulbs obtained from sampled plants were measured for equatorial diameter in centimeter. The mean equatorial diameter of the bulb was worked out.

Polar diameter of bulb (cm)

Polar diameter of the bulb is the distance from the base of root plate to the neck of the bulb from the same five bulbs, which were used for recording equatorial diameter. Measured by Vernier Caliper, Mean of bulb was worked out.

Average weight of bulb (g)

After harvesting, total weight of five randomly selected bulbs was recorded and then mean weight of one bulb was worked out for each replication of all treatments and expressed in gram.

Grading of bulbs

The bulbs harvested from each plot were categorized into 3 categories on the basis of size.

Grade Diameter of bulb (mm)

A : > 60 mm

B : 40 - 60 mm

C : < 40 mm

'A' grade bulbs (%)

The 'A' grade sized bulbs (> 60mm) were selected and the percentage of 'A' grade bulbs was computed on weight basis.

'B' Grade bulbs (%)

The 'B' grade sized bulbs (40-60mm) were selected accordingly with 'A' grade and they were weighted separately. The percentage of 'B' grade bulbs in each plot was computed on weight basis.

C' Grade bulbs (%)

Percentage of 'C' grade sized bulbs (<40 mm) calculated similarly as 'A' grade and 'B' grade percent.

Premature bolting (%)

From each plot, number of bolted plants was marked differently and they were harvested separately from each plot from each replication. Then its percentage was worked out by dividing total number of bolted plants to the total plants from each plot.

Twin bulb (Doubles) (%)

All twin bulbs were separated from each plot and weight was taken separately. By dividing weight of twin bulbs *i.e.* doubles to the total weight from each plot its percentage worked out.

Total bulb yield (t/ha)

After harvesting yield of onion bulbs from each plot yield was calculated which was converted into tones per hectare.

Marketable bulb yield (t/ha)

From total yield only percentage of doubles and bolters were deducted and marketable yield was calculated. The yield obtained was converted into tonnes per hectare.

Table-1 Effect of pre harvest treatments on polar diameter and equatorial diameter of bulbs (cm) at harvest

Treatment	Average weight of bulb (g)	Equatorial diameter (cm)	Polar diameter (cm)
T_1 : Streptocycline 200 Ppm	64.47	4.93	4.32
T_2 : Copper oxychloride 0.25 %	62.06	4.67	3.98
T_3 : Streptocycline 200 Ppm + Copper oxychloride 0.25 %	65.25	4.54	3.98
T_4 : Cycocel 500 Ppm	64.62	5.07	4.21
T_5 : Cycocel 1000 Ppm	66.17	4.92	4.00
T_6 : Carbendazim 1000 Ppm	69.79	5.34	4.53
T_7 : Carbendazim 2000 Ppm	71.51	5.49	4.85
T_8 : Mancozeb 0.25 %	66.3	4.91	3.98
T_9 : Azoxystrobin 1000 Ppm	60.56	4.56	3.87
T10-Control	61.49	5.38	4.61
Standard Error of MEAMS	2.78	0.35	0.23
Critical Difference at 5 %	NS	NS	NS

Table-2 Effect of pre harvest treatments on A, B and C grade bulbs (%) of onion

Treatment	% A grade bulbs	% B grade bulbs	% C grade bulbs	Twin bulbs %	Premature Bolters %
T_1 : Streptocycline 200 Ppm	19.41	64.31	15.57	0.63	0.08
T_2 : Copper oxychloride 0.25 %	20.33	65.59	13.34	0.64	0.10
T_3 : Streptocycline 200 Ppm + Copper oxychloride 0.25 %	21.37	67.43	10.74	0.30	0.16
T_4 : Cycocel 500 Ppm	18.43	68.23	12.90	0.28	0.16
T_5 : Cycocel 1000 Ppm	20.25	68.00	10.95	0.80	0.00
T_6 : Carbendazim 1000 Ppm	18.20	70.14	11.17	0.34	0.15
T_7 : Carbendazim 2000 Ppm	21.40	62.19	16.41	0.00	0.00
T_8 : Mancozeb 0.25 %	20.36	66.23	13.01	0.40	0.00
T_9 : Azoxystrobin 1000 Ppm	17.15	68.45	13.35	0.90	0.15
T_{10} : Control	19.30	65.30	13.20	1.78	0.42
Standard Error of MEAMS	1.95	1.85	2.03	0.32	0.13
Critical Difference at 5 %	NS	NS	NS	NS	NS

Table-3 Effect of pre harvest treatments on total bulb yield of onion (t/ha)

Treatment	Total bulb yield (t/ha)	Marketable bulb yield (t/ha)
T_1 : Streptocycline 200 Ppm	33.56	33.32
T_2 : Copper oxychloride 0.25 %	29.83	29.62
T_3 : Streptocycline 200 Ppm + opper oxychloride 0.25 %	30.81	30.66
T_4 : Cycocel 500 Ppm	30.02	29.89
T_5 : Cycocel 1000 Ppm	29.75	29.51
T_6 : Carbendazim 1000 Ppm	31.72	31.56
T_7 : Carbendazim 2000 Ppm	38.81	38.81
T_8 : Mancozeb 0.25 %	29.41	29.29
T_9 : Azoxystrobin 1000 Ppm	32.05	31.71
T_{10} : Control	31.91	31.21
Standard Error of MEAMS	1.84	1.99
Critical Difference at 5 %	NS	NS

Storage quality parameters

After harvesting, 10 kg bulbs from each replication and treatments were stored in cages on 22 May, 2013. The observations were recorded at 30, 60, 90, 120, 150 and 180 days after harvesting on plw, rotting, sprouting, black mould and total storage losses were estimated at every month

Physical parameters

Physiological Loss in Weight (%)

The weight of the bulbs was recorded on 30, 60, 90, 120, 150 and 180 days after storage using an electronic balance. The cumulative loss in weight of bulbs was calculated and expressed as % plw using the formula given below.

PLW (%) = Po - P_1 or P_2 or P_3 or P_4 or P_5 or P_6 / Po x 100

Where Po = Initial weight

P_1 = Weight after 30 days

P_2 = Weight after 60 days

P_3 = Weight after 90 days

P_4 = Weight after 120 days

P_5 = Weight after 150 days

P_6 = Weight after 180 days

Rotting percentage

The weight of the rotted bulbs at the end of 30, 60, 90, 120, 150 and 180 days after storage was recorded under each treatment and rotting percentage calculated.

Rotting percentage = Weight of the rotted bulbs / Initial weight of the bulbs x 100

Sprouting percentage

For determining the sprouting percentage on respective days after storage, the bulbs showing a sprout were separated from the lot and weighted on an electronic balance. The percentage of sprouting calculated by using formula given below.

Sprouting percentage = Weight of sprouted bulbs / Initial Weight of bulbs x 100

Statistical analysis

The data recorded for each observation in this present investigation was analyzed statistically as per the procedure described by (15). The standard error and critical difference for each observation was determined.

Result

Yield parameters

Equatorial diameter of bulb (cm)

The data regarding mean equatorial diameter of bulb was presented in [Table-1]. The results were non significant due to pre-harvest spray of chemicals. However, the maximum equatorial diameter was noticed in treatment T_7 (Carbendazim 2000 Ppm) *i.e.* (5.49 cm)

Polar diameter of bulb (cm)

The data regarding mean polar diameter of bulb was presented in [Table-1] registered non significant differences due to pre-harvest spray of chemicals, however the maximum polar diameter was recorded by treatment T_7 (Carbendazim 2000 Ppm) *i.e.* (4.85 cm).

Average bulb weight (g)

The data presented in [Table-1] revealed that, average weight of bulb was found non significant due to pre-harvest spray of chemicals but the maximum average bulb weight observed in treatment T_7 (Carbendazim 2000 Ppm) (71.51 g).

'A' Grade bulb (%)

The data recorded in [Table-2] revealed that, the 'A' grade bulbs were recorded maximum in treatment T_7 (Carbendazim 2000 Ppm) (21.40 %) followed by treatment T_3 (Streptocycline 200 Ppm + Copper oxychloride 0.25 %) (21.37 %). Though the results were non significant.

'B' grade bulb (%)

The data regarding to average B grade bulbs in % are presented in [Table-2] was found non-significant. Though the results were non significant in respect of 'B' grade bulbs the maximum percentage of 'B' grade bulbs was observed in treatment T_6 (Carbendazim 1000 Ppm) (70.14 %) followed by treatment T_9 (Azoxystrobin 1000 Ppm) (68.45 %).

'C' grade bulb (%)

The data related to the effect of various chemicals on 'C' grade bulbs (%) are presented in [Table-2] was found non-significant however, maximum percentage of 'C' grade bulbs was recorded by the treatment T_7 (Carbendazim 2000 Ppm) (16.41 %) followed by treatment T_1 (Streptocycline 200 Ppm) (15.57 %)

Bolter bulb (%)

The observations pertaining to percentage bolting of bulbs is depicted in [Table-2]. There was non significant difference observed among the various treatments however, no bolters were observed in treatment T_7 (Carbendazim 2000 Ppm) and treatment T_8 (Mancozeb 0.25 %) (0.00 %) while it was highest in treatment T_{10} (control) (0.42 %).

Twin bulb (%)

The data recorded in [Table-2] regarding percentage of twin bulbs (doubles) revealed that differences were statistically non-significant. Though no twin bulbs were observed in treatment T_7 (Carbendazim 2000 Ppm) (0.00 %) followed by treatment T_4 (Cycocel 500 Ppm) (0.28 %) while, it was highest in treatment T_{10} (control) (1.78 %).

Total bulb yield (t/ha)

The data on total bulb yield and marketable bulb yield were presented in [Table-3]. The treatment differences were non-significant for these two characters influenced by various chemical pre-harvest treatments. The treatment T_7 (Carbendazim 2000 Ppm) recorded numerically the highest total bulb yield (38.81 t/ha). The lowest yield (29.41 t/ha) was recorded in T_8 Mancozeb 0.25% treatment.

Marketable bulb yield (t/ha)

The data in respect of marketable bulb yield of onion has been given in [Table-3]. There were non significant differences observed regarding the marketable yield due to various chemical treatments. While, it was highest (38.81 t/ha) in the treatment T_7 (Carbendazim 2000 Ppm).

Physical parameters

Physiological Loss in Weight (PLW %)

The data on Physiological Loss in Weight (%) of onion *Cv.* N-2-4-1 recorded during the storage period of 30, 60, 90, 120, 150 and 180 days after storage was presented in [Table-4]. Treatment difference were significantly influenced by various chemical treatments. Irrespective of pre-harvest treatments, the mean PLW was increased progressively as increase in storage period. As regards the 30 days observation, it was revealed from the data presented in [Table-4] that, significant difference were noticed among the treatments. The treatment T_7 (Carbendazim 2000 Ppm) found most superior and recorded 3.32 least loss of plw (3.32 %) as compare to all other treatments. The treatment T_{10} (Control) recorded maximum plw (7.16 %).

Table-4 Effect of pre harvest treatments on Physiological Loss in Weight (%) of onion during storage

Treatment	Days after storage (DAS)					
	30	60	90	120	150	180
T_1 : Streptocycline 200 Ppm	4.38	8.3	12.38	14.69	23.69	24.36
T_2 : Copper oxychloride 0.25 %	5.03	9.43	14.01	18.4	24.4	24.73
T_3 : Streptocycline 200 Ppm + Copper xychloride 0.25 %	4.79	8.7	13.87	16.24	23.57	24.24
T_4 : Cycocel 500 Ppm	4.02	7.56	12.5	14.29	21.63	23.63
T_5 : Cycocel 1000 Ppm	3.85	7.1	12.2	14.19	19.23	20.49
T_6 : Carbendazim 1000 Ppm	3.6	6.68	11.34	12.44	18.77	20.44
T_7 : Carbendazim 2000 Ppm	3.32	6.03	10.59	12.06	17.06	19.73
T_8 : Mancozeb 0.25 %	5.35	10.33	13.68	16.22	20.05	23.38
T_9 : Azoxystrobin 1000 Ppm	6	10.46	12.83	18.25	22.92	25.59
T_{10} : Control	7.16	12.01	17.3	22.43	26.43	28.76
Standard Error of MEAMS	0.25	0.52	0.38	0.46	0.65	0.77
Critical Difference at 5 %	0.74	1.55	1.13	1.37	1.92	2.28

As regards the 60 days observation, it was revealed from the data that, the treatment T_7 (Carbendazim 2000 Ppm) found significantly superior and recorded least plw (6.03 %) as compared to all the treatments. The treatment T_{10} (Control) recorded maximum plw (12.01 %). As regards 90 days observation, it was observed from the data that, significant difference was noticed among the treatments. The treatment of Carbendazim 2000 Ppm found significantly superior and recorded least loss of plw (10.59 %) as compare to all the treatments. The treatment T_{10} (Control) recorded maximum plw (17.30 %). The plw at 120 days observation, it was revealed from the data that, the treatment of Carbendazim 2000 Ppm found significantly superior and recorded least loss of plw (12.06 %) as compare to all the treatments. From the data it was recorded that treatment T_{10} (Control) showed maximum plw (22.43 %). The plw at 150 days observation, it was observed from the data that, the treatment of Carbendazim 2000 Ppm found most superior and recorded minimum loss of plw (17.06 %) which was at par with the treatment T_6 (Carbenzadim 1000 Ppm) (18.77 %). The treatment T_{10} (Control) recorded highest plw (26.43 %) as compare to all the treatments. The data regarding plw at 180 days observation, showed that, the treatment of Carbendazim 2000 Ppm found most superior and recorded minimum loss of plw (19.73 %) as compare to all the treatments. The treatment T_7 (Carbendazim 2000 Ppm) was found on par with the treatment T_6 (Carbendazim 1000 Ppm) and the T_5 (Cycocel 1000 Ppm) showed (20.44 %) and (20.49 %) plw. The treatment T_{10} (Control) recorded maximum plw (28.76 %) as compare to all the treatments.

Sprouting (%)

The data on sprouting (%) of onion N-2-4-1 during the storage period of 30, 60, 90, 120, 150 and 180 days after storage was presented in [Table-5]. Sprouting (%) was increased progressively as increase in storage period. The data regarding sprouting losses showed non significant differences at 30 and 60 days after storage. As regards the 90 days observation, it was revealed from the data presented in [Table-5] that, significant difference were noticed among the treatments. The treatments of Cycocel 500 Ppm and 1000 Ppm were found most superior and showed least loss of sprouting (0.00 %) which was on par with treatment T_7 (Carbendazim 2000 Ppm) recorded (0.00 %) sprouting.

Table-5 Effect of pre harvest treatments on sprouting (%) of onion during storage

Treatment	Days after storage (DAS)					
	30	60	90	120	150	180
T_1 : Streptocycline 200 Ppm	0.00	0.00	0.38	0.81	1.09	1.32
T_2 : Copper oxychloride 0.25 %	0.00	0.00	0.52	0.78	1.26	2.37
T_3 : Streptocycline 200 Ppm + Copper oxychloride 0.25 %	0.00	0.00	0.76	0.86	0.92	1.19
T_4 : Cycocel 500 Ppm	0.00	0.00	0.00	0.25	0.59	1.42
T_5 : Cycocel 1000 Ppm	0.00	0.00	0.00	0.00	0.43	1.06
T_6 : Carbendazim 1000 Ppm	0.00	0.00	0.36	0.65	0.75	2.42
T_7 : Carbendazim 2000 Ppm	0.00	0.00	0.00	0.50	0.57	1.57
T_8 : Mancozeb 0.25 %	0.00	0.00	0.57	0.77	1.17	2.83
T_9 : Azoxystrobin 1000 Ppm	0.00	0.00	0.70	0.73	1.06	2.33
T_{10} : Control	0.00	0.00	1.90	2.00	3.13	4.06
Standard Error of MEAMS	0.00	0.00	0.04	0.06	0.08	0.15
Critical Difference at 5 %	NS	NS	0.13	0.18	0.24	0.43

At 120 days observation, it was observed from the data that, there were significant difference was noticed among the treatments. The treatment of T_5 (Cycocel 1000 Ppm) was found superior and recorded least loss of sprouting (0 %) than rest of

treatments. The treatment T_{10} (Control) recorded maximum sprouting losses (2.00 %). As regards the 150 days observation, it was revealed from the data that, significant difference was noticed among the treatments. The treatment T_5 (Cycocel 1000 Ppm) was found most superior and observed least loss of sprouting (0.43 %). Similarly, this treatment was found on par with the treatment of T_7 and T_4 showed (0.57 %) and (0.59 %) sprouting. The treatment T_{10} (Control) recorded maximum sprouting losses (3.13 %). The data regarding sprouting losses at 180 days after storage showed, significant difference among the treatments. The treatment of Cycocel 1000 Ppm was found most superior and recorded least loss of sprouting (1.06 %) which was on par with the treatment T_3, T_1, T_4 and showed sprouting (1.19 %), (1.32 %) and (1.42 %) sprouting losses. The treatment T_{10} (Control) recorded maximum sprouting losses (4.06 %) as compare to all the treatments.

Rotting (%)

The data regarding rotting losses of onion N-2-4-1 during the storage period of 30, 60, 90, 120, 150 and 180 days after storage was presented in [Table-6].

Rotting (%) was increased progressively as increase in storage period. Rotting (%) at 30 days observation recorded from the data presented in [Table-6] showed that, there was significant differences noticed among the treatments. The treatment T_7 (Carbendazim 2000 Ppm) was most superior and recorded no loss of rotting (0 %) over all other treatments. The treatment T_{10} (Control) showed maximum rotting losses (4.07 %) as compare to all the treatments. The data regarding rotting losses at 60 days observation show, significant difference among the treatments. The treatment T_7 (Carbendazim 2000 Ppm) was found most superior and recorded least loss of rotting (0.92 %).

This treatment was at par with T_6 and T_1 showed rotting (1.19 %) and (1.61 %). The treatment T_{10} (Control) recorded maximum rotting losses (5.11 %). As regards the 90 days observation, it was revealed from the data that, the treatment T_7 (Carbendazim 2000 Ppm) was at par with treatment T_6 (Carbendazim 1000 Ppm) showed 2.11 % and 2.78 % rotting. The treatment T_{10} (Control) recorded maximum rotting losses (12.52 %) as compare to all the treatments.

Table-6 Effect of pre harvest treatments on rotting (%) of onion during storage

Treatment	Days after storage (DAS)					
	30	60	90	120	150	180
T_1 : Streptocycline 200 Ppm	0.83	1.61	3.30	4.75	5.21	8.41
T_2 : Copper oxychloride 0.25 %	2.13	2.38	6.17	6.35	8.17	8.28
T_3 : Streptocycline 200 Ppm + Copper oxychloride 0.25 %	2.34	3.54	4.06	4.17	7.67	8.47
T_4 : Cycocel 500 Ppm	1.09	2.99	4.18	7.42	11.53	11.61
T_5 : Cycocel 1000 Ppm	1.15	2.47	3.57	6.18	10.58	10.64
T_6 : Carbendazim 1000 Ppm	0.73	1.19	2.78	3.77	4.49	7.28
T_7 : Carbendazim 2000 Ppm	0.00	0.92	2.11	3.29	4.10	5.21
T_8 : Mancozeb 0.25 %	2.03	2.09	5.75	5.94	9.88	11.72
T_9 : Azoxystrobin 1000 Ppm	3.14	4.11	6.21	6.32	12.58	14.56
T_{10} : Control	4.07	5.11	12.52	13.58	14.16	15.71
Standard Error of MEAMS	0.15	0.18	0.37	0.35	0.44	0.54
Critical Difference at 5 %	0.44	0.54	1.10	1.03	1.31	1.61

The data regarding rotting losses at 120 days observation showed, the treatment T_7 (Carbendazim 2000 Ppm) was found superior and showed least rotting losses (3.29 %). This treatment T_7 which was at par with treatments T_6 and T_3 showed (3.77 %) and (4.17 %). The treatment T_{10} (Control) recorded maximum rotting losses (13.58 %). The observation at 150 days after storage showed the treatment T_7 (Carbendazim 2000 Ppm) was found most superior and recorded minimum rotting (4.10 %) which was on par with treatment T_6 and T_1 showed rotting losses (4.49 %) to (5.21 %). The treatment T_{10} (Control) recorded maximum rotting losses (14.16 %) as compare to all the treatments.

As regards the 180 days observation, it was revealed from the data that, there was significant difference were noticed among the treatments. The treatment T_7 (Carbendazim 2000 Ppm) was found superior over all other treatments and recorded least rotting losses (5.21 %). The treatment T_{10} (Control) recorded maximum rotting losses (15.71 %) as compare to all the treatments.

Total loss (%)

The data regarding to total storage losses of onion N-2-4-1 recorded during the storage period of 30, 60, 90, 120, 150 and 180 days after storage was presented in [Table-7]. Treatment differences were significantly influenced by various chemical treatments.

Table-7 Effect of pre harvest treatments on total loss (%) of onion during storage

Treatment	Days after storage (DAS)					
	30	60	90	120	150	180
T_1 : Streptocycline 200 Ppm	5.21	9.91	16.57	20.25	30.00	34.19
T_2 : Copper oxychloride 0.25 %	7.17	11.81	21.04	25.53	33.83	35.39
T_3 : Streptocycline 200 Ppm + Copper oxychloride 0.25 %	7.13	12.25	18.33	21.26	32.16	33.90
T_4 : Cycocel 500 Ppm	5.12	10.55	16.32	21.96	33.74	36.65
T_5 : Cycocel 1000 Ppm	5	9.57	15.47	20.37	30.24	32.20
T_6 : Carbendazim 1000 Ppm	4.34	7.87	14.27	16.86	24.02	30.13
T_7 : Carbendazim 2000 Ppm	3.32	6.95	12.48	15.85	21.73	26.51
T_8 : Mancozeb 0.25 %	7.38	12.43	18.85	22.92	31.09	37.94
T_9 : Azoxystrobin 1000 Ppm	9.14	14.57	20.83	25.3	36.56	42.48
T_{10} : Control	11.23	17.12	31.44	38.01	43.72	48.53
Standard Error of MEAMS	0.33	0.56	0.69	1.05	1.00	1.32
Critical Difference at 5 %	0.98	1.67	2.04	3.11	2.98	3.94

Total losses at 30 days observation recorded from the stored bulbs and data presented in [Table-7] showed that, the treatment T_7 (Carbendazim 2000 Ppm) was found significantly superior and recorded minimum total storage losses (3.32 %) as compare to all the treatments. The treatment T_{10} (Control) recorded maximum total storage losses (11.23 %). As regards at the 60 days storage observation, it was revealed from the data significant difference were noticed among the treatments the treatment T_7 (Carbendazim 2000 Ppm) was found significantly superior and recorded least total losses (6.95 %) as compare to all the treatments. The treatment T_{10} (Control) recorded maximum total storage losses (17.12 %). At 90 days observation, it was revealed from the data that, treatment T_7 (Carbendazim 2000 Ppm) was found significantly superior and recorded least total storage losses (12.48 %) as compare to all the treatments. The treatment T_{10} (Control) recorded maximum total storage losses (31.44 %).

As regards the 120 days observation, it was revealed from the data that, treatment T_7 (Carbendazim 2000 Ppm) recorded minimum total losses (15.85 %) which was significantly superior as compare to all the treatments. The treatment T_{10} (Control) recorded maximum total storage losses (38.01 %). The data related to 150 days observation showed significant difference among the treatments. The treatment T_7 (Carbendazim 2000 Ppm) was found most superior and recorded least total loss (21.73 %), which was at par with treatment T_6 (Carbendazim 1000 Ppm) (24.02 %). The treatment T_{10} (Control) recorded maximum total storage losses (43.72 %). Total losses at 180 days observation recorded from the data showed that, the treatment T_7 (Carbendazim 2000 Ppm) was found most superior and recorded least total loss (26.51 %) which was at par with treatment T_6 (Carbendazim 1000 Ppm) showed losses (30.13 %)). The treatment T_{10} (Control) recorded maximum total storage losses (48.53 %).

Discussion

Yield and yield contributing parameters

The data obtained for yield and yield contributing parameters were statistically non significant. The reason behind it was that, the pre harvest chemical spray was taken at just start of neck fall when, vegetative growth and bulb development was completed. Hence, there were no any treatments effect observed on yield character of onion N-2-4-1.

Physiological Loss in Weight

Among the treatments tried, T_7 (Carbendazim 2000 Ppm) sprayed at the just start of neck fall was found to be the most effective in reducing PLW. The plw at 30, 60, 90, 120, 150 and 180 DAS was found significantly difference. The least PLW was recorded in T_7 (Carbendazim 2000 Ppm) followed by T_6 (Carbendazim 1000 Ppm). These results are in agreement with Chavan, *et al*., (1992) [6], Gupta, (1992) [7].

Rotting and black mould (%)

In the present study, carbendazim 2000 Ppm and 1000 Ppm as pre-harvest sprays were found effective in improving the storability of onion bulb. However, the treatment with carbendazim 2000 Ppm was found more effective in reducing rotting and black mould when they were sprayed at the start of neck fall. This may be due to the broad spectrum fungicidal effect on post-harvest pathogen. The reduction in rotting % could be attributed to positive effect of carbendazim in controlling black mould rot (Aspergillus niger) responsible for decay of bulbs. Similar findings were reported by Kamat, *et al*., (1997) [8], Laxman, (2005)[9], Maheshwari, *et al*., (1988)[10], Omveen, *et al*., (1987)[11], Panse and Sukhatme, (1985)[12], Patil and Kale, (1989)[13], Rajapakse and Edirimanna, (2002)[14], Singh and Dhankhar (1995)[15], Sinha, *et al*., (1994)[16], Srivastava, *et al*., (1996)[17], Singh and Sharma, (2002)[18] in onion.

Sprouting (%)

The % sprouting was minimum in cycocel 1000 Ppm followed by cycocel 500 Ppm, when they were sprayed at the start of neck fall. This may be due to the prolonged dormancy or sprout inhibition for longer period after harvest by cycocel. This could be attributed to reduced neck thickness in sprayed bulbs and by way of minimised cell division and due to the removal of apical dominance inhibiting sprout initiation. The results of the present investigation are in conformity with the findings of Anbukkarasi, *et al*., (2013) [19], Bhujbal and Patil, (1978) [20], Chaobasingh and Bhattacharjee, (1998) [21].

Conclusion

From the above finding it can be concluded that for reducing Storage losses and extending shelf life of onion pre harvest sprays of carbendazim 2000 ppm is beneficial and very effective.

Application of research: To enhance storage life reduce storage losses and improve keeping quality of onion.

Research Category: Horticulture

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Study area / Sample Collection: Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar, 413722, India

Cultivar / Variety / Breed name: Onion (*Allium cepa* L.) N-2-4-1

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