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Effect of pre-harvest foliar sprays of chemicals on storage life of onion var. Arka Kalyan

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Abstract
Effect of pre-harvest treatments involving different chemicals viz salisylic acid, calcium chloride, boric acid, azoxystrobin, carbendazim and putrescine on storage life of onion was studied. Among the treatments, minimum physiological loss in weight (14.66 %) was recorded in salisylic acid (2mM) (T_2) treatment. Application of salisylic acid (4mM) (T_3) showed minimum sprouting (3.74 %). Whereas minimum rotting (7.76 %) was recorded in azoxystrobin (0.05 %) (T_8) and application of carbendazim (0.1 %) (T_9) showed maximum (61.87 %) recovery of marketable bulbs at the end of 90 days of storage. Hence from the present study it can be concluded that salisylic acid, azoxystrobin and carbendazim are found to be effective in maintaining the storage life of onion when compared to the control.

Keywords: Onion, salisylic acid, azoxystrobin, carbendazim

Introduction
Onion being high in water content, it is a delicate commodity to store. Serious losses occur due to rotting, sprouting, physiological loss in weight and moisture evaporation. Therefore, the crop requires special procedure and parameters for storage. In general, the losses due to reduction in weight, sprouting and rotting (decay) were found to be 20 to 25 per cent, 4 to 8 per cent and 8 to 12 per cent respectively (Sharma, 2012) [8]. Pre-harvest treatments have also been applied to reduce post harvest losses without impairing the quality of onion. A pre-harvest spray of maleic hydrazide (2000-2500 ppm) 15 days before harvest prevents rotting and sprouting of bulbs (Sharma, 2012) [8]. However, maleic hydrazide has been banned for use from 2014. Alternatively, other chemicals and some new molecules could be employed as pre-harvest foliar spray to extend the shelf life and reduce spoilage in onions. The chemicals like salisylic acid, calcium chloride, boric acid, azoxystrobin, carbendazim and putrescine treatment as pre-harvest foliar sprays have gained prominence in fruit crops. They have great role in the maintenance of quality of onion bulbs in storage with respect to inhibition of rotting and reduction in the physiological loss in weight. Hence the present study was conducted to study the effects of pre-harvest sprays of chemicals on storage life of onion.

Materials and methods
Field experiment was conducted at College of Horticulture, Bagalkot, in Karnataka during the kharif season of the year 2014-15. The experiment was laid out in Randomised Complete Block Design (RCBD) with ten treatmens and three replications. The experimental plot size was 1.8 * 1.8. In the present study Arka Kalyan variety of onion was used. The treatments includes : T_1-Control, T_2-Salicylic acid (2 mM), T_3-Salicylic acid (4 mM), T_4- Boric acid (0.25%), T_5-Boric acid (0.5%), T_6-Calcium chloride (0.5%), T_7-Calcium chloride (1.0 %), T_8-Azoxystrobin (0.05%), T_9 -Carbendazim (0.1 %) and T_{10}-Putrescine (8 mM). These treatments were sprayed to the foliage three weeks before harvest using hand sprayer. The crop was harvested at 102 days after transplanting by gentle pulling then it is cured with foliage in the field for one week after that it is shade cured for 15 days. From the cured bulbs 5kg onions from each treatments were selected and replicated thrice after sorting and packing in the gunny bags and then kept in ambient condition for storage studies. The observations were recorded on physiological loss in weight, sprouting, rotting and marketable bulbs at 30, 60 and 90 days after storage (DAS).

Physiological loss in weight (%)
The cumulative losses in weight of bulbs were calculated and expressed as per cent physiological loss in weight using the formula given below.

$$PLW\ (\%) = \frac{P0 - P1 \text{ or } P2 \text{ or } P3}{P0} \times 100$$

Where,
P_0 = initial weight P_1 = weight after 30 days
P_2 = weight after 60 days P_3 = weight after 90 days

Sprouting percentage
For determining the sprouting percentage on stipulated days after storage, the bulbs showing a sprout were separated from the lot and weighed on an electronic balance. The sprouting percentage, which indicated the weight of the bulbs sprouted at 30, 60 and 90 DAS was calculated by using the formula given below.

$$\text{Sprouting percentage} = \frac{\text{Weight of the sprouted bulbs}}{\text{initial weight of the bulbs}} \times 100$$

3.5.2.6 Rotting percentage

$$\text{Rotting percentage} = \frac{\text{Weight of the rotten bulbs}}{\text{Initial weight of the bulbs}} \times 100$$

$$\text{Marketable bulbs (\%)} = \frac{\text{Weight of the healthy bulbs obtained}}{\text{Initial weight of bulbs stored}} \times 100$$

Statistical analysis
Statistical analysis was performed using Web Agri Stat Package (WASP) version 2.0 (Jangam and Thali, 2010). All the data collected were analysed by one-way analysis of variance (ANOVA). Significant differences among means at p=0.05 were determined by post hoc tests using Duncan's multiple range test.
Significant differences were observed among the treatments with respect to PLW, sprouting, rotting and marketable bulbs throughout the storage period (Table 1). 90 days after storage significantly least (14.66 %) PLW was recorded in T_2-salisylic acid (2mM) and the highest PLW was recorded in T_1-control. The effect of the salicylic acid in the reduction of PLW may possibly be related to the decrease of the metabolic activity, such as respiration and production of ethylene (Freddo *et al.,* 2013) [3]. Lower PLW recorded in bulbs treated with salicylic acid in the present study is in accordance with the results noticed by Shafiee *et al.* (2010) [7] in strawberry fruits. With respect to sprouting significantly least (3.74 %) sprouting was found in treatment T_3- salisylic acid (4mM) it may due to the fact that salicylic acid inhibited mitotic index in onion root cells (Trushin, 2013) [9]. However, salicylic acid at relatively high doses caused an inhibitory effect on plant growth of tomato (Hathout, 1992).
The sprouting per cent was high in T_5 (Boric acid-0.5%) (6.90%) followed by T_7 ($CaCl_2$ -1%) (6.73%) and T_1 (Control) (6.64%). %). In general, the losses in onions due to sprouting were found to be 4 to 8 per cent (Sharma, 2012) [8]. Majority of the treatments in the current study showed sprouting losses in the range stated by Sharma (2012) [8] indicating that these chemicals were not considerably effective in further reducing sprouting.
The rotting per cent at the end of 90 days of storage was significantly lower in T_8 (Azoxystrobin-0.05%) (7.76%) followed by T_9 (Carbendazim - 0.1 %) (7.89). Azoxystrobin is a broad spectrum fungicide with protectant, curative, eradicant and systemic properties. (Anand *et al.,* 2010) [1]. The maximum rotting was noted in the treatment T_6 ($CaCl_2$-0.5%) (10.69 %), T_1 (Control) (10.68 %) and T_4 (Boric acid- 0.25%) (10.30%). In general, the losses in onion due to rotting (decay) were found to be 8 to 12 per cent (Sharma *et al*., 2012) [8]. However, most of the rotten bulbs showed the incidence of onion bulb maggot (*Delia antiqua*). Hence, the higher rotting observed in T_6 ($CaCl_2$-0.5%) (10.69%), T_4 (Boric acid- 0.25%) (10.30%) and T_1 (Control) (10.68%) was probably due primarily to the damage inflicted by the insect followed by infection (Brewster, 2008) [2].
The data related to the effects of pre harvest foliar sprays on marketable onion bulbs during ambient storage are presented in Table 1. Availability of maximum quantity of healthy and sound bulbs is of paramount importance for better sale and to get good returns. The maximum percentage of marketable bulbs at the end of 90 days of storage was obtained in the treatment T_9 (Carbendazim - 0.1 %) (61.87%) followed by T_8 (Azoxystrobin-0.05%) (57.00%). This may be attributed to reduction of rotting in these treatments. These results are in conformity with the findings of Robak and Adamicki, (2007) in carrot and kukanoor (2005) [5] in onion. In contrast, minimum per cent marketable bulbs at the end of 90 days of storage were obtained in treatment T_6 ($CaCl_2$ - 0.5%) (43.30. As already discussed before, most of the unmarketable bulbs exhibited the damage caused by onion bulb maggot (*Delia antiqua*). According to Brewster (2008) [2], maggots of the second and third generations burrow in to the bases of large plants and developing bulbs and thereby predispose them to rotting by secondary infections of fungi and bacteria. Female flies oviposit maximally in a substrate at about 20ºC, a temperature that also favours egg survival and development (Keller and Miller, 1990) [4]. Hence, the lower percentage of marketable bulbs in these treatments might be due primarily to the damage inflicted by the insect followed by infection. This observation points to the need for inclusion of an insecticide as pre-harvest spray specifically to take care of onion bulb maggot.

Table 4: Effect of pre-harvest sprays on physiological loss in weight, respiration rate, sprouting and rotting of onions (variety Arka Kalyan) stored under ambient condition

Treatments	PLW (%)			Sprouting (%)			Rotting (%)			Marketable bulbs (%)		
	Days			Days			Days			Storage (Days)		
	30	60	90	30	60	90	30	60	90	30	60	90
T_1	7.7^{a}	13.1^{a}	20.1^{a}	4.34^{ab}	4.78^{bc}	6.64^{ab}	2.71^{a}	7.18ab	10.68^{a}	83.63^{ef}	68.43^{b}	53.20^{bcd}
T_2	3.4^{e}	8.5^{g}	14.7^{h}	2.23^{ef}	3.38^{d}	3.93^{ef}	1.65^{c}	5.28^{def}	8.03^{b}	85.53^{c}	69.37^{b}	54.37^{bc}
T_3	4.2^{d}	9.3^{f}	15.5^{g}	1.39^{f}	3.57^{d}	3.74^{f}	1.56^{c}	6.60^{bc}	9.55^{a}	83.03^{f}	64.33^{d}	51.23^{bcd}
T_4	5.9^{c}	11.5^{d}	17.4^{d}	3.23^{bcde}	3.55^{d}	4.75^{de}	2.20^{b}	7.40^{a}	10.30^{a}	84.40^{de}	69.20^{b}	49.73^{cde}
T_5	4.7^{d}	10.5^{e}	16.5^{ef}	5.42^{a}	6.46^{a}	6.99^{a}	1.70^{c}	5.96^{cd}	9.90^{a}	81.63^{g}	67.93^{bc}	55.03^{abc}
T_6	6.2^{bc}	12.1^{bc}	19.1^{b}	2.82^{de}	3.68^{cd}	5.34^{cd}	2.98^{a}	7.44^{a}	10.69^{a}	77.83^{h}	56.93^{e}	43.30^{e}
T_7	4.5^{d}	10.2^{e}	16.1^{fg}	4.16^{bc}	5.24^{b}	6.73^{ab}	1.90^{bc}	5.77^{de}	10.18^{a}	82.73^{f}	66.20^{cd}	47.37^{de}
T_8	6.5^{bc}	12.0^{cd}	17.0^{de}	3.73^{bcd}	4.47^{bcd}	5.07^{cd}	1.00^{d}	4.20^{g}	7.76^{b}	89.43^{a}	71.97^{a}	57.00^{ab}
T_9	6.6^{d}	12.7^{ab}	18.3^{c}	3.00^{cde}	5.17^{b}	5.90^{bc}	1.10^{d}	4.89^{fg}	7.89^{b}	88.43^{b}	69.50^{b}	61.87^{a}

T_{10}	4.5^{b}	10.^{1e}	16.0^{fg}	3.00^{cde}	3.50^{d}	4.10^{ef}	1.60^{c}	5.00^{ef}	8.07^{b}	85.23^{cd}	67.53^{bc}	53.60^{bcd}
Mean	5.4	11.0	17.1	3.33	4.38	5.32	1.84	5.97	9.31	84.19	67.14	52.67
S.Em±	0.223	0.197	0.255	0.397	0.387	0.315	0.135	0.266	0.433	0.302	0.690	2.353
CD@5%	0.681	0.592	0.741	1.119	1.159	0.931	0.386	0.793	1.292	0.903	2.055	6.995

Note: Values with the same superscripts in same column are not significantly different by Duncan Multiple Range Test at $p \leq 0.05$

Conclusions

Pre-harvest spray of azoxystrobin (0.05%) and Carbendazim (0.1%) resulted in less bulb rotting and higher marketable bulbs indicating superior performance of the treatments. Salicylic acid both at 2 mM (T_2) and 4 mM (T_3) were found maintaining reduced PLW, sprouting. But, salicylic acid at 2 mM exhibited reduced rotting. Putrescine also performed on par with the top treatments with respect to sprouting, rotting. In general, the lower percentage of marketable bulbs obtained in all treatments appears to be primarily due to the damage inflicted by the onion bulb maggot (*Delia antiqua*) which predisposed the bulbs to rotting by secondary infections of fungi and bacteria. Hence, there is a need to control onion bulb maggot to precisely comprehend the effectiveness of pre-harvest sprays used in the present study.

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