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Influence of salicylic acid on growth, yield and quality attributes of onion under temperate conditions

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Abstract
An experiment was conducted during rabi-2017-18, and 2018-2019 at experimental field of Division of Vegetable Sciences of, SKUAST-Kashmir with six treatments and three replications in randomised block design. The treatment consists of foliar spray of Salicylic acid at the rate of 250 mg/L at different intervals to study difference in plant height (cm), number of leaves, polar diameter (cms), Equatorial diameter (cm), Average bulb weight (gms), neck thickness and bulb yield including quality as well as storage parameters of onion bulb. The pooled results indicated that significant improvement in vegetative, growth yield and quality parameters were found as compared to control application. Foliar application of salicylclic acid at 30 & 120 days after transplanting recorded maximum plant height (81.55 cms), number of leaves/plant (12.95), Average Bulb weight (98.70 gms), maximum polar diameter (6.38 cms), equatorial diameter (7.16 cms), total bulb yield (322.81 q ha^{-1}), neck thickness (0.46 cms), and also same treatment registered maximum quality attributes like dry matter content (15.31), soluble solid content (11.92 ^{0}Brix), Pyruvic Acid (µmol g^{-1}) content (7.66 mg/100 g) besides lowest storage losses were also recorded with same treatment (9.15%).

Keywords: onion, salicylic acid, growth, yield, quality

Introduction
Onion (*Allium cepa L.*) "queen of kitchen" is one of the most important commercial crop not only in India but also in the world. India ranks first in area, and next in production after china. In India, onion is being grown in an area of 1270.00 (000 ha) with a production of 21564.00(000 t) and the productivity is 17.30 t ha^{-1} (Annoymous, 2017-18). Although India has highest area under onion, still it stands second in the production of onion in the world. Hence there is a lot of potential for increasing the production by improving the yields.

In Kashmir onion is grown on an area of 950 ha with a annual production of 24250 t and the productivity is 25.52 t ha^{-1} (Annoymous, 2017). Since the India is the larger exporter of onion foreign exchange. Productivity could be increased by use of suitable varietites, balanced nutrition, need based agronomic practices Ortho-hydroxy benzoic acid is a common plant produced phenolic compound. It is an endogenous growth regulator which contributes in the regulation of physiological, biochemical and molecular processes and therefore it effects the plant growth, development and productivity (Hayat *et al.*, 2010) [6]. Numerous studies have documented the influence of endo and exogenous SA on stomatal closure (Saaverda, 1979) [12], iion uptake and transport (Khadiga and Bebars, 1993) [9]. inhibition of ethylene biosynthesis, transpiration and stress tolerance (Waseem *et al.*, 2006) [16], Photosynthetic pigments in leaves (Yildirim *et al.*, 2008) [17], Plant Photosynthesis (Fariduddin *et al.*, 2003) [4] and on nitrogen metabolism owing to SA producing a positive impact on the activity of nitrate reductase (Fariduddin *et al.*, 2003), [4] Synthesis of secondary plant metabolites and on antioxidant activity (Eraslan *et al.*, 2007) [3] or the improved plant tolerance to heavy metals (Guo *et al.*, 2009; Popova *et al.*, 2008) [5, 11]. Eraslan *et al.*, (2007) [3] also reported that exogenous application of salicylic acid, enhanced growth, physiological processes and antioxidant activity of carrot plants grown under salinity stress. However, higher concentrations of salicylic acid had an inhibitory effect.

Salycylic acid sprayed at lower concentrations significantly as reported by Larque and Martin, 2007; Javari *et al*., 2012) [7]. Shraiy and Hegazi 2009 [15] revealed positive effects of SA application on total soluble proteins., phenol, total soluble carbohydrates and sugars in pea (*Pisum Sativum* L.).

Materials and Methods

A field experiment was conducted during rabi-2017-18, and 2018-2019 at Faculty of Horticulture, SKUAST-Kashmir The experiment was laid in a randomised block design with three replications.

The seeds of onion cv. Yellow globe were sown in august to raise seedlings for transplanting 8-10 weeks old. Recommended package of practices were followed as per university guidelines. Salycylic acid at the rate of 250 mg/L of water were given as foliar spray at different days interval.

Ten plants from each plot were selected randomly and tagged for recording observations. The growth parameters viz., plant height (cm) and number of leaves were recorded 45 days after transplanting. At harvest time 10 bulbs were choosen at randomly from every plot and the following data were recorded; neck thickness, polar diameter (cm), equatorial diameter (cm), average bulb weight (g).

Total Bulb yield (t/ha), total dry matter content, solid soluble content ($Brix^0$), Pyruvic Acid content and total storage loss were recorded at the end of harvest. The Observations on growth, yield, quality, storage life were recorded, using standard procedures. The recorded data was subjected to stastiscal analysis as per the procedure suggested by Panse and Sukhatame, (1989) [10]. Pyruvic acid was determined by using the procedures of Randle and Ketter (1998) [8].

The treatment details are

T_1: Foliar application of Salycylic acid at 30 DAT
T_2: Foliar application of Salicylic Acid at 60 DAT
T_3: Foliar application of Salicylic Acid at 120 DAT
T_4: Foliar application of Salicylic Acid at 30 & 60 DAT
T_5: Foliar application of Salicylic Acid at 30 & 120 DAT
T_6: water *DAT days after transplanting,

Results and Discussion

Effect of Salicylic acid on growth, yield and yield related attributes of onion (*Allium sativum L.)* (Table-1 and Table -2)

The results of the present study showed that foliar application of salicylic acid significantly affected the growth, yield and yield related attributes of onion. The effect of salicylic acid on the growth, yield, quality and storage components were described here as under:

Data presented in the table-1 revealed that plant height and no. of leaves per plantt were significantly enhanced due to foliar application of salycylic acid at 30 &120 days after transplanting (T_5) during rabi 2017-18 (80.46 cms, 13.23), rabi 2018-19 (82.64 cms, 12.67) and after pooling data (81.55 cms,12.95) respectively as compared to rest of all other treatments but no. of leaves were at par with treatment with T_4 (foliar application of salycylic acid at 30 &60 days after transplanting) during both seasons (2017-8 and 2018-19 and also after pooling of data) (table-1) whereas control treatment (T_6) recorded lowest values of plant height and no. of leaves per plant during both seasons (table-1).

Average bulb weight and total bulb yield differed significantly among different treatments and it was found that treatment T_5 (foliar application of salycylic acid at 30 &120 days after transplanting recorded significantly maximum values during rabi 2017-18 (97.10 gms, 323.66 q ha^{-1}),rabi 2018-19 (100.30 gms, 334.29 q ha^{-1}) and after pooling data (98.70 gms, 322.81 q ha^{-1}) respectively as compared to rest of all other treatments whereas control treatment (T_6) recorded minimum values of average bulb weight and total bulb yield during both seasons (table-1 and table -2).

As per table-2 it was revealed that treatment T_5 (foliar application of salycylic acid at 30 &120 days after transplanting) recorded significantly maximum values in most cases for polar diameter and equatorial diameter values during rabi 2017-18 (6.30 cms,7.06cms) rabi 2018-19 (6.47 cms,7.26 cms) and after pooling data (6.38 cms,7.16 cms) respectively as compared to rest of all other treatments followed by treatment T_4 (foliar application of salycylic acid at 30 &60 days after transplanting) but treatment T_5 recorded minimum values for neck thickness during during rabi 2017-18 (0..46 cms),rabi 2018-19 (0.48cms) and after pooling data (0.46 cms) respectively as compared to rest of all other treatments where as control treatment (T_6) recorded lowest values of polar and equatorial diameter) but maximum values for neck thickness during both seasons (table-2).This increase might be due to stimulating dry mass production through enhancement of cell division and cell enlargement (Hayat *et al*., 2005), and chlorophyll accumulation which reflected on vegetative growth of onion plants. Shakirova *et al* 2003 [14] revealed the positive effect of salicylic acid on growth and yield can be attributed its influence on other plant hormones. Salicylic acid altered the auxins, cytokinins and ABA balances in wheat and increased the growth and yield under both normal and saline conditions. Similar findings were also reported by Bideshki and Arvin (2010) [2] in garlic. Onion leaves are storage organ of the food materials and it get translocated into the bulbs at the time of maturity. Hence the number of leaves play a major role in bulb yield and quality (Sathiyamurthy *et al*., 2017) [13]. our findings are in line with Amir Zeb *et al*., 2017 [18] Bideshki and Arvin (2010) [2] and (.Sathiyamurthy *et al*., 2017) [13].

Table1: Effect of salicylic acid on growth, and yield attributes of onion (*Allium sativum L.)*.

Treatment Salicylic Acid @250 mg/L	Plant height (cms)			No. of leaves plant^{-1}			Average Bulb Weight (gms)		
	2017-18	2018-19	pooled	2017-18	2018-19	pooled	2017-18	2018-19	pooled
T_1 = 30 DAP	72.00	73.50	72.75	11.56	11.00	11.28	85.00	88.62	86.80
T_2 = 60 DAP	73.43	74.25	73.67	11.80	11.33	11.56	86.56	89.16	88.19
T_3 = 120 DAP	74.40	75.00	74.00	12.03	11.67	11.85	87.30	91.04	89.17
T_4=30&60 DAP	76.50	77.25	76.87	12.60	12.33	12.46	90.83	94.52	92.67
T_5 = 30 &120 DAP	**80.46**	**82.64**	**81.55**	**13.23**	**12.67**	**12.95**	**97.10**	**100.30**	**98.70**
T_6 = water	68.73	69.35	69.04	10.46	10.33	10.40	81.73	84.25	82.99
c.d ($p \leq 5$ %)	4.24	3.36	1.08	0.71	2.19	1.09	5.06	1.95	2.97

Table 2: Effect of salicylic acid on Yield and Yield related attributes of onion (*Allium sativum L.)*.

Treatment Salicylic Acid @250 mg/L	Polar Diameter (cms)			Equatorial Diameter (cm)			Neck thickness (cm)			Total Bulb Yield Q ha^{-1}		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
T_1 = 30 DAP	5.43	5.56	5.49	5.96	6.10	6.03	0.56	0.57	0.56	283.33	295.37	288.85
T_2 = 60 DAP	5.50	5.60	5.54	6.30	6.38	6.34	0.54	0.54	0.54	288.55	297.17	292.86
T_3 = 120 DAP	6.13	5.93	6.02	6.37	6.42	6.39	0.53	0.53	0.53	291.10	303.43	297.26
T_4=30&60 DAP	6.00	6.15	6.07	6.43	6.60	6.51	0.53	0.49	0.51	302.77	314.63	308.70
T_5 = 30 &120 DAP	6.30	6.47	6.38	7.06	7.26	7.16	0.46	0.48	0.46	323.66	334.29	322.81
T_6 = water	5.10	5.16	5.14	5.09	5.98	5.95	0.63	0.66	0.64	272.44	280.80	276.62
c.d (p≤ 5 %)	0.62	0.17	0.330	0.31	0.14	0.190	0.07	0.03	0.046	16.91	3.48	8.94

Effect of Salicylic acid on quality attributes and storage life of onion (*Allium sativum L.)*
(Table -3)

Dry matter content, TSS, Pyruvicid acid content and storage life of onion bulbs was significantly influenced by application of salicylic acid as compared to no application. As per table-3 it was found that treatment T_5(foliar application of salicylic acid at 30 &120 days after transplanting) recorded maximum values for drymatter content, solid soluble content, pyruvic acid content sources during rabi 2017-18 (15.43 gms,11.83 Brix^0,7.60µmolg^{-1}), rabi 2018-19 (15.20 gms,12.01 Brix^0,7.72µmolg^{-1})) and after pooling data (15.31 gms,11.92 Brix^0,7.66µmolg^{-1}) respectively which significantly superior as compared to rest of all other treatments where as control treatment (T_6) recorded lowest values of for dry matter content, TSS pyruvicid acid content during both seasons (table-3).The improvement of quality parameters of bulb may be attributed to increased carbohydrates production during photosynthesis and consequently more translocation of assimilates towards bulb (Source to sink relationship) (Sathiyamurthy *et al*., 2017) [13] (table -3).

As per storage losses are concerned it was revealed that total storage losses were found significantly lowest with treatment T_5 (foliar application of salicylic acid at 30 & 120 days after transplanting) during rabi 2017-18 (27.94 %), rabi 2018-19 (29.27 %) and after pooling data (28.61%) respectively as compared to rest of all other treatments but at par with treatment T_4 where as control treatment (T_6) recorded highest storage losses during both seasons and after pooling of data (table-3).The enhancement of storage quality i.e reduction of storage losses of bulbs due to application of salicylic acid may be attributed to the increase in total dry matter content of onion bulbs as compared to control treatment (T_6) (table -3).

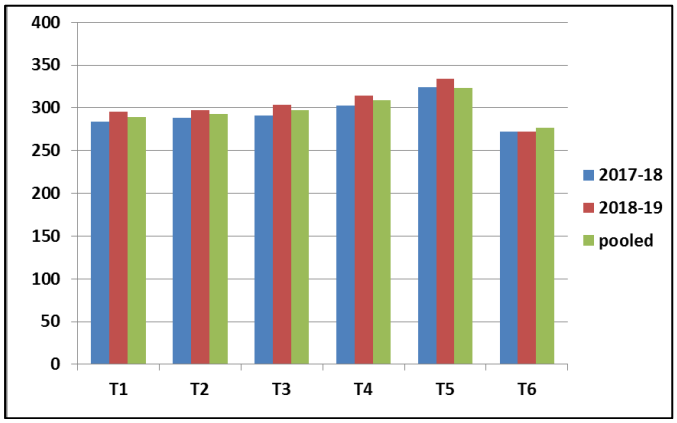

Fig 1: Effect of salicylic acid on total bulb yield (q ha^{-1}) of onion.

Table 3: Effect of salicylic acid on quality parameters and storage losses of onion (*Allium sativum L.)*.

Treatment Salicylic Acid @250 mg/L	Dry matter Content (gms)			Soluble solid content (Brix^0)			Pyruvic Acid (µmol g^{-1})			Total Storage losses		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
T_1 = 30 DAP	13.10	13.16	13.12	10.14	10.16	10.13	6.70	6.65	6.67	36.90	37.63	37.26
T_2 = 60 DAP	13.80	13.76	13.78	10.50	10.52	10.51	6.76	6.81	6.78	34.63	34.93	34.78
T_3 = 120 DAP	13.80	13.85	13.82	10.67	10.70	10.68	7.00	7.04	7.01	32.97	33.16	33.06
T_4= 30&60 DAP	13.97	14.01	14.00	10.76	10.81	10.78	7.15	7.11	7.13	30.07	30.60	30.33
T_5 =30&120 DAP	15.43	15.20	15.31	11.83	12.01	11.92	7.60	7.72	7.66	27.94	29.27	28.61
T_6 = water	12.67	13.15	12.90	10.00	10.05	10.03	6.30	6.34	6.35	40.88	40.73	40.81
c.d (p≤ 5 %)	0.67	0.86	0.57	0.43	0.05	0.21	0.36	0.05	0.17	2.73	3.58	2.07

Conclusion

The results can be summarised as, the foliar application of salicylic acid @250 mg/litre at 30 and 120 DAT is useful to promote better growth, yield and quality besides improving storage life of onion bulbs also.

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