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 salicylic 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 °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 variettes, 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], ion uptake and transport (Khadiga and Bebars, 1993) [9], inhibition of ethylene biosynthesis, transpiration and stress tolerance (Waseem et al., 2006) [10], Photosynthetic pigments in leaves (Yildirim et al., 2008) [13], Plant Photosynthesis (Fariduddin et al., 2003) [4] and on nitrogen metabolism owning 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.
Salicylic acid sprayed at lower concentrations significantly as reported by Larque and Martin, 2007; Java et al., 2012 [3]. Shraiy and Hegazi 2009 [13] revealed positive effects of SA application on total soluble carbohydrates, 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. Salicylic 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 chosen at random 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°), 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 statistical 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

T1: Foliar application of Salicylic acid at 30 DAT
T2: Foliar application of Salicylic Acid at 60 DAT
T3: Foliar application of Salicylic Acid at 120 DAT
T4: Foliar application of Salicylic Acid at 30 & 60 DAT
T5: Foliar application of Salicylic Acid at 30 & 120 DAT
T6: water 1” DAT days after transplanting,

Results and Discussion
Effect of Salicylic acid on growth, yield and root 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 root related attributes of onion. The effect of salicylic acid on the growth, yield, quality and storage components were described here as under:

| Treatment       | Plant height (cms) | No. of leaves plant−1 | Average Bulb Weight (gms) |
|-----------------|--------------------|------------------------|---------------------------|
| Salicylic Acid @ 250 mg/L | 2017-18 2018-19 pooled | 2017-18 2018-19 pooled |
| T1 = 30 DAP     | 72.00              | 11.56                  | 85.00                     |
| T2 = 60 DAP     | 73.43              | 11.80                  | 89.16                     |
| T3 = 120 DAP    | 74.40              | 12.03                  | 91.04                     |
| T4 = 30 & 60 DAP| 76.50              | 12.60                  | 90.83                     |
| T5 = 30 & 120 DAP| 80.46             | 13.23                  | 97.10                     |
| T6 = water      | 68.73              | 10.46                  | 81.73                     |
| c.d (p<5 %)     | 4.24               | 0.71                   | 5.06                      |

Table 1: Effect of salicylic acid on growth, and yield attributes of onion (Allium sativum L.).

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

| Treatment | Polar Diameter (cm) | Equatorial Diameter (cm) | Neck thickness (cm) | Total Bulb Yield Q ha⁻¹ |
|-----------|---------------------|--------------------------|---------------------|-------------------------|
| Salicylic Acid @250 mg/L | 2017-18 2018-19 Pooled | 2017-18 2018-19 Pooled | 2017-18 2018-19 Pooled | 2017-18 2018-19 Pooled |
| T₁ = 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 |
| T₂ = 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 |
| T₃ = 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 |
| T₄ = water | 6.00 6.15 6.07 | 6.43 6.60 6.51 | 0.53 0.49 0.51 | 302.77 314.63 308.70 |
| T₅ = 30 &60 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 |
| T₆ = 120 DAP | 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.)

Dry matter content, TSS, Pyruvic 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 T₃(foliar application of salicylic acid at 30 &120 days after transplanting) recorded maximum values for dry matter content, solid soluble content, pyruvic acid content sources during rabi 2017-18 (15.43 gms,11.83 Brix⁷,7.60µmolg⁻¹), rabi 2018-19 (15.20 gms,12.01 Brix⁷,7.72µmolg⁻¹) and after pooling data (15.31 gms,11.92 Brix⁷,7.66µmolg⁻¹) respectively which significantly superior as compared to rest of all other treatments where as control treatment (T₀) recorded lowest values for dry matter content, TSS pyruvic 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) (table -3).

As per storage losses are concerned it was revealed that total storage losses were found significantly lowest with treatment T₃ (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 T₁ where as control treatment (T₀) 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 (T₀) (table -3).

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

| Treatment | Dry matter Content (gms) | Soluble solid content (Brix) | Pyruvic Acid (µmol g⁻¹) | Total Storage losses |
|-----------|--------------------------|-----------------------------|------------------------|---------------------|
| Salicylic Acid @250 mg/L | 2017-18 2018-19 Pooled | 2017-18 2018-19 Pooled | 2017-18 2018-19 Pooled | 2017-18 2018-19 Pooled |
| T₁ = 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 |
| T₂ = 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 |
| T₃ = 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 |
| T₄ = water | 13.97 14.01 14.00 | 10.76 10.81 10.78 | 7.15 7.11 7.13 | 30.07 30.60 30.33 |
| T₅ = 30 &60 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 |
| T₆ = 120 DAP | 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 0.45 0.21 | 0.05 0.26 0.05 | 0.17 2.73 3.58 |

Fig 1: Effect of salicylic acid on total bulb yield (q ha⁻¹) of onion.

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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