

Original Research Article

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Effect of Salicylic Acid on growth and yield of Onion (*Allium cepa* L.)

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ABSTRACT

The field experiment was carried out at Scheme for Research on Onion Storage, Department of Horticulture, Mahatma Phule krishi Vidyapeeth, Rahuri during the *rabi* season of 2015-16 to study the effect of salicylic acid on onion (*Allium cepa* L.) cv. N-2-4-1. The experiment was laid out in a Factorial Randomized block design with two replications consisting two factors, Factor-A (03) with levels of concentration and water spray and Factor-B (07) with seven levels of time of applications. The result indicated that, there was significant influence of foliar application of salicylic acid on growth parameters viz., plant height (68.28-76.45 cm), number of leaves per plant (13.15-15.30), neck thickness (0.84-1.07) and higher level of chlorophyll content (0.58-0.75 mg 100 g⁻¹ f.w) as compare to water spray. The foliar application of salicylic acid at lower concentration (100 mg/l) gives significantly maximum plant height, number of leaves per plant, total chlorophyll content, bulb diameter, average weight of bulb, total bulb yield, marketable bulb yield as compare to higher dose (150 mg/l) and water spray. Three foliar sprays at 30, 45 and 60 DAT were beneficial for vegetative growth, yield, quality and storability of onion cv. N 2-4-1 than either single or two sprays of salicylic acid.

Keywords

Onion, vegetative growth, chlorophyll, salicylic acid, yield

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Introduction

Onion (*Allium cepa* L.) is being extensively cultivated all over the world. India is the 2nd largest producer of onion, in the world next only to China but the productivity of onion in India is very low. It occupies an area of 12.03 lakh ha, with production lakh tonnes. The export of onion during 2013-14 was 14.82 lakh MT with a value of Rs 316.961 crores (Anon. 2014). As far as onion production per hectare is concerned, improved and modern agronomic practices and application of Plant Growth Regulators (PGRs) might be useful in

increasing onion production. In recent years, salicylic acid has been the focus of intense research due to its function as an endogenous signal mediating local and systemic plant defense responses against pathogens.

Salicylic acid (SA) is a phenolic phytohormone that acts as a key regulator of the signaling network in plants under abiotic and biotic stresses. Salicylic acid exerts stimulatory effects on various physiological processes related to plant growth and development. The purpose of this study was to test the hypothesis that exogenous application

of SA affects positively the growth, quality and yield. Salicylic acid (C₇H₆O₃) discovered as one of the important phenolic compounds in plants (Chandra *et al.*, 2007).

This substance naturally is produced in plants in very low amounts. Various physiological and biochemical effects of salicylic acid on plant systems have been documented (Raskin, 1992). Salicylic acid treatment increases or decreases chlorophyll content, depending on the genotype (Chandra and Bhatt 1998). Salicylic acid a natural molecule plays an important role in regulating a number of physiological processes in plants. Its exogenous application has promoted plant performance under biotic and abiotic stresses (Senaratna *et al.*, 2000). Foliar spray of low concentration of salicylic acid promote and influence the growth, development, differentiation of cells, and tissues of plants and enhanced the plant's growth parameters (Helgi and Rolfe 2005).

Considering the above facts, the present investigation entitled "Effect of salicylic acid on onion (*Allium cepa* L.)" was planned to test the effect of salicylic acid as a foliar spray at different time of applications

Materials and Methods

The present trial entitled "Effect of salicylic acid on 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 of 2015-16. 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. Climatically, this area is in semi-arid, sub-tropical zone, with annual average rainfall 475 mm. The annual mean maximum and minimum temperature are 35.83⁰ and 17.82⁰, respectively during the period of

experimentation. The onion seed was sown in raised beds in nursery for seedling preparation. Main field was prepared to fine tith and flat beds of 3 X 2 m were prepared. At the time of land preparation experimental site was applied manure and fertilizers as recommended. The healthy seedlings of onion were transplanted on 12th January, 2015 with spacing of 15 x 10 cm.

Weeding was done manually throughout the growing season. The crop was harvested on 2nd May, 2016. At harvest the growth parameters like plant height, number of leaves and neck thickness observed from ten randomly selected plants and observations recorded. After harvesting of bulb different size bulb, A grade (>60 mm), B grade (40-60 mm) and C grade (<40 mm) were selected and their percentage were computed on weight basis. Total bulb yield (q ha⁻¹) and marketable bulb (%) were calculated. The data recorded for each observation in this present investigation was analyzed statistically as per the procedure described by Panse and Sukhatme (1989).

Results and Discussion

Growth parameters

Plant height (cm)

It was revealed that the differences in mean plant height due to salicylic acid treatments were observed to be statistically significant and presented in Table 1. The balance of internal level of natural auxins due to salicylic acid is mainly responsible for maintaining physiological activities in the plant system and that significantly resulted into better growth and more plant height.

Among the conc. of salicylic acid, A₁ recorded maximum plant height (73.73 cm) which was significantly superior over A₂ and A₃. The time

of application effect was non-significant. The interactions effects were non-significant, however the combination A₁B₇ (T₇) recorded the maximum plant height (76.45 cm) and the combination A₃B₂ (T₁₆) recorded minimum plant height (62.97 cm).

Number of leaves per plant

The data pertaining to number of leaves per plant as influenced by different salicylic acid treatments and time of application was recorded at harvest and presented in Table 1. It was revealed that the differences in mean number of leaves per plant due to salicylic acid treatments were observed to be statistically significant. The exogenous application of SA had effect on increased photosynthetic activity and cell division which enhances the number of leaves per plant (Gharib, 2006).

Among the conc. of salicylic acid, A₁ recorded maximum number of leaves per plant (14.61) which were significantly superior to A₂ and A₃ treatments. The time of application effects were non-significant. With respect to interactions effect were non-significant, however the combination A₁B₇ (T₇) recorded the maximum number of leaves per plant (15.30) and the combination A₃B₄ (T₁₈) recorded minimum number of leaves per plant (11.64).

These findings are close relevant with the result of Jain and Srivastava (1981) in maize, Gutierrez–Coronado *et al.*, (1998) in soyabean, Pankaj and Sharma (2003) in okra, Amin *et al.*, (2007) in onion, Jeyakumar *et al.*, (2008) in black gram, Pradhan *et al.*, (2016) and Prajapati *et al.*, (2016) in onion.

Neck thickness (cm)

It was revealed that the differences in mean neck thickness of plant due to salicylic acid

treatments were observed to be statistically significant and results are presented in Table 1. Neck thickness of onion is important parameter since it is the neck which is ultimately going to be converted into bulb. Hence, more the neck thickness more will be size of bulb and yield (Shashikumar and Shashidhar, 2015). Neck thickness rapidly reduced 90 days after transplanting in onion due to maturity.

Among the conc. of salicylic acid, A₃ recorded minimum neck thickness (0.75 cm) which was significantly higher than A₁ and A₂ treatments. With respect to time of applications effect was non-significant. The interactions effect were non-significant, however the combination A₃B₅ (T₁₉) recorded minimum neck thickness (0.71 cm). The combination A₁B₇ (T₇) recorded the maximum neck thickness (1.07 cm). The result obtained are in close agreement with the observation recorded by Sakhabutdinova *et al.*, (2003) in wheat, Pankaj and Sharma (2003) in okra, Amin *et al.*, (2007), Pradhan *et al.*, (2016), Prajapati *et al.*, (2016) in onion.

Yield and yield contributing characters

The data pertaining to yield contributing characters *viz.*, polar and equatorial diameter, average weight of bulb (g) and grades of bulbs (%) was recorded during the present investigation and result data presented in Table 2.

Polar diameter (cm)

Among SA conc., the maximum polar diameter of bulb (4.82 cm) recorded in A₁ which was significantly higher than A₂ and A₃. Among the time of application effect was non-significant, however the maximum polar diameter of bulb (4.63 cm) was recorded in B₇. However, the minimum polar diameter of bulb (4.48 cm) was recorded in B₁.

Table.1 Effect of salicylic acid concentrations and time of applications on plant height (cm), number of leaves, neck thickness (cm)

Treatment	Plant height(cm)		Number of leaves		Neck thickness (cm)	
Factor A						
A ₁	73.73		14.61		0.99	
A ₂	70.37		13.56		0.92	
A ₃	65.42		12.04		0.75	
Factor B						
B ₁	70.09		13.25		0.85	
B ₂	68.66		13.38		0.87	
B ₃	69.31		13.42		0.90	
B ₄	69.87		13.15		0.91	
B ₅	70.57		13.58		0.87	
B ₆	70.08		13.52		0.88	
B ₇	70.29		13.53		0.92	
Interaction						
A ₁ B ₁	74.50		13.95		0.92	
A ₁ B ₂	72.46		14.10		0.99	
A ₁ B ₃	71.31		14.70		0.98	
A ₁ B ₄	73.32		14.10		0.99	
A ₁ B ₅	73.72		14.85		1.02	
A ₁ B ₆	74.33		15.25		0.98	
A ₁ B ₇	76.45		15.30		1.07	
A ₂ B ₁	71.91		13.70		0.86	
A ₂ B ₂	70.55		13.85		0.84	
A ₂ B ₃	70.40		13.70		0.97	
A ₂ B ₄	69.97		13.70		0.98	
A ₂ B ₅	71.09		13.65		0.89	
A ₂ B ₆	70.38		13.15		0.92	
A ₂ B ₇	68.28		13.20		0.96	
A ₃ B ₁	63.87		12.10		0.78	
A ₃ B ₂	62.97		12.20		0.79	
A ₃ B ₃	66.23		11.85		0.77	
A ₃ B ₄	66.31		11.64		0.76	
A ₃ B ₅	66.91		12.26		0.71	
A ₃ B ₆	65.55		12.15		0.73	
A ₃ B ₇	66.13		12.10		0.75	
	S.E.±	CD at 5 %	S.E.±	CD at 5 %	S.E.±	CD at 5 %
Factor A	0.51	1.52	0.11	0.34	0.012	0.037
Factor B	0.79	NS	0.18	NS	0.019	NS
Interaction	1.37	NS	0.31	NS	0.033	NS

Table.2 Effect of salicylic acid concentrations and time of applications on polar diameter (cm), equatorial diameter (cm) and average weight of bulb (g)

Treatment	Polar diameter (cm)		Equatorial diameter(cm)		Average weight of bulb(g)	
Factor A						
A ₁	4.82		5.62		81.74	
A ₂	4.56		5.32		77.80	
A ₃	4.23		4.91		73.07	
Factor B						
B ₁	4.48		5.22		76.68	
B ₂	4.50		5.24		76.88	
B ₃	4.51		5.25		76.99	
B ₄	4.55		5.30		77.62	
B ₅	4.52		5.29		77.42	
B ₆	4.55		5.32		77.86	
B ₇	4.63		5.39		79.30	
Interaction						
A ₁ B ₁	4.61		5.38		78.52	
A ₁ B ₂	4.65		5.42		78.98	
A ₁ B ₃	4.86		5.65		81.76	
A ₁ B ₄	4.90		5.69		82.32	
A ₁ B ₅	4.86		5.71		82.48	
A ₁ B ₆	4.86		5.67		81.98	
A ₁ B ₇	5.02		5.85		86.16	
A ₂ B ₁	4.49		5.23		76.78	
A ₂ B ₂	4.47		5.20		76.43	
A ₂ B ₃	4.55		5.28		77.42	
A ₂ B ₄	4.55		5.31		77.66	
A ₂ B ₅	4.52		5.30		77.55	
A ₂ B ₆	4.65		5.43		79.15	
A ₂ B ₇	4.67		5.46		79.58	
A ₃ B ₁	4.35		5.06		74.75	
A ₃ B ₂	4.38		5.10		75.22	
A ₃ B ₃	4.12		4.81		71.78	
A ₃ B ₄	4.20		4.91		72.87	
A ₃ B ₅	4.18		4.85		72.23	
A ₃ B ₆	4.16		4.87		72.44	
A ₃ B ₇	4.21		4.85		72.17	
	S.E.±	CD at 5 %	S.E.±	CD at 5 %	S.E.±	CD at 5 %
Factor A	0.02	0.07	0.03	0.09	0.43	1.27
Factor B	0.03	NS	0.04	NS	0.66	NS
Interaction	0.06	0.19	0.08	0.24	1.14	3.37

Table.3 Effect of salicylic acid concentrations and time of applications on total bulb yield and marketable bulb (%)

Treatment	Total bulb yield (kg plot ⁻¹)		Total bulb yield (qha ⁻¹)		Marketable bulb (%)	
Factor A						
A ₁	27.95		463.01		93.24	
A ₂	27.10		384.01		90.17	
A ₃	19.69		318.82		87.24	
Factor B						
B ₁	24.91		413.55		92.33	
B ₂	24.54		407.34		90.22	
B ₃	21.98		364.79		89.21	
B ₄	23.19		384.98		89.49	
B ₅	23.07		382.95		89.11	
B ₆	22.09		366.71		91.28	
B ₇	24.10		400.00		89.86	
Interaction						
A ₁ B ₁	27.95		464.00		92.87	
A ₁ B ₂	26.83		445.35		93.69	
A ₁ B ₃	28.00		464.79		93.39	
A ₁ B ₄	27.98		464.51		92.77	
A ₁ B ₅	28.88		479.42		91.81	
A ₁ B ₆	25.89		429.75		93.48	
A ₁ B ₇	29.72		493.27		94.64	
A ₂ B ₁	27.10		449.78		93.53	
A ₂ B ₂	27.25		452.34		92.58	
A ₂ B ₃	19.15		317.82		88.14	
A ₂ B ₄	22.59		374.98		90.40	
A ₂ B ₅	21.57		358.13		88.12	
A ₂ B ₆	21.60		358.56		90.38	
A ₂ B ₇	22.68		376.47		88.03	
A ₃ B ₁	19.69		326.87		90.59	
A ₃ B ₂	19.54		324.31		84.39	
A ₃ B ₃	18.78		311.76		86.11	
A ₃ B ₄	19.00		315.44		85.30	
A ₃ B ₅	18.75		311.29		87.41	
A ₃ B ₆	18.78		311.81		89.97	
A ₃ B ₇	19.90		330.27		86.92	
	S.E.±	CD at 5 %	S.E.±	CD at 5 %	S.E.±	CD at 5 %
Factor A	0.29	0.85	4.82	14.18	0.50	1.47
Factor B	0.44	1.30	7.36	21.67	0.76	NS
Interaction	0.76	2.26	12.7	37.54	1.32	NS

Treatment details

Factor A – concentration of salicylic acid and water spray (03)

1	:	Salicylic acid @ 100 mg/l
2	:	Salicylic acid @ 150 mg/l
3	:	Water spray

Factor B – Stages of application (07)

1	:	2 nd spray at 30 days after transplanting(DAT)
2	:	2 nd spray at 45 DAT
3	:	2 nd spray at 60 DAT
4	:	2 nd spray at 30 DAT and 3 rd spray at 45 DAT
5	:	2 nd spray at 30 DAT and 3 rd spray at 60 DAT
6	:	2 nd spray at 45 DAT and 3 rd spray at 60 DAT
7	:	2 nd spray at 30 DAT and 3 rd spray at 45 DAT and 4 th spray at 60 DAT

Note: 1st spray of salicylic acid @ 250 mg/l was given at 30 days after sowing at nursery stage common for all treatments, except water spray treatments.

The interaction effect were significant, however the combination A₁B₇ (T₇) recorded the maximum polar diameter of bulb (5.02 cm) was at par with the combination A₁B₄ (T₄) (4.90 cm), A₁B₃ (T₃), (4.86 cm), A₁B₅ (T₅) (4.86 cm) A₁B₆ (T₆) (4.86 cm). Thus resulting higher values of polar diameter in onion bulbs similar findings reported by Ibrahim and Sanna (2005), Amin *et al.*, (2007), Prajapati *et al.*, (2016) and Pradhan *et al.*, (2016) in onion and Bideshki Arvin (2010) in garlic.

Equatorial diameter (cm)

With respect to the concentrations of salicylic acid, the maximum equatorial diameter of bulb (5.62 cm) recorded in A₁ which was significantly superior to A₂ and A₃ treatments. Among the time of application effect was non-significant.

The interaction effect were significant, however the combination A₁B₇ (T₇) recorded the maximum equatorial diameter of bulb (5.85 cm) was at par with the combination A₁B₅ (T₅) (5.71 cm), A₁B₄ (T₄) (5.69 cm), A₁B₆ (T₆) (5.67 cm) and A₁B₃ (T₃) (5.65 cm).

These findings are close agreement with Amin *et al.*, (2007) in onion and Bideshki and Arvin (2010) in garlic and Prajapati *et al.*, (2016) and Pradhan *et al.*, (2016) in onion Meena *et al.*, (2016) in garlic.

Average weight of bulb (g)

It was revealed that the differences in mean average weight of bulbs due to salicylic acid treatments were observed to be statistically significant.

Considering the conc. of salicylic acid the maximum average weight of bulb (81.74 g) recorded in A₁ which was significantly superior over A₂ and A₃ treatments. The interaction effects were significant, however the combination A₁B₇ recorded the maximum average weight of bulb (86.16 g) significantly. These results are in close agreement with Amin *et al.*, (2007), Pradhan *et al.*, (2016) and Prajapati *et al.*, (2016) in onion.

Total bulb yield (kg plot⁻¹)

The data regarding to total bulb yield per plot

as influenced by different salicylic acid treatments and time of application and presented in Table 3. It is revealed that the differences in regard of total bulb yield due to various treatments of salicylic acid were observed to be statistically significant. Considering the concentration of salicylic acid effects was significant and the highest total bulb yield (27.95 kg plot⁻¹) was recorded in which was at par with A₂ (27.10 kg plot⁻¹). Among the time of application, the maximum total bulb yield kg plot⁻¹ (24.91 kg plot⁻¹) was recorded in B₁ which was significantly superior to all the remaining except B₂ (24.54 kg plot⁻¹) and B₇ (24.10 kg plot⁻¹) which was at par with it. With respect to interactions, the combination A₁B₇ (T₇) recorded the maximum total bulb yield (29.72 kg plot⁻¹) was at par with A₁B₅ (T₅) (28.88 kg plot⁻¹), A₁B₃ (T₃) (28.00 kg plot⁻¹), A₁B₄ (T₄) (27.98 kg plot⁻¹) and A₁B₁ (T₁) (27.95 kg plot⁻¹). These findings are closely related with Ibrahim and Sanaa (2005) in onion, Amin *et al.*, (2007) in onion, Yildirim and Dursun (2009) in tomato, Bideshki and Arvin (2010) and Meena *et al.*, (2016) in garlic, Prajapati *et al.*, (2016) and Pradhan *et al.*, (2016) in onion.

Marketable bulb (%)

The data regarding to marketable bulb (%) as influenced by different salicylic acid treatments and time of application are presented in Table 3.

Considering the concentrations of salicylic acid, effect was significant and the highest marketable bulb percentage (93.24 %) was recorded in A₁. Among the time of application, the highest marketable bulb percentage (92.33 %) was recorded in B₁ and lowest marketable bulb percentage (89.11 %) recorded in B₅. The interaction effect were non-significant, however the combination A₁B₇ (T₇) recorded the maximum marketable

bulb percentage (94.64 %). The minimum marketable bulb percentage (84.39 %) recorded in A₃B₂ (T₁₆). From the foregoing results and discussion, it could be concluded as:

The foliar application of salicylic acid at lower concentration (100 mg/l) gives significantly maximum plant height, number of leaves per plant, total chlorophyll content, bulb diameter, average weight of bulb, total bulb yield, marketable bulb yield with significantly minimum purple blotch incidence and thrips incidence as compare to higher dose (150 mg/l) and water spray.

Foliar application of salicylic acid at 30 DAS during nursery stage and subsequently 2nd spray at 30 DAT, 3rd spray at 45 DAT and 4th spray at 60 DAT during crop growth stage gives more growth, quality and yield parameters than single spray.

The combination A₁B₇ (T₇) (1st spray of 250 mg/l, 2nd spray SA @ 100 mg /lit at 30 DAT, 3rd spray SA @ 100 mg/lit at 45 DAT and 4th spray @ 100 mg/lit at 60 DAT) not only recorded maximum growth parameters but also recorded the highest total bulb yield of 493.27 q ha⁻¹ and marketable bulb percentage (94.64%) with minimum storage losses.

Summing the present investigation, it can be concluded that, foliar application of SA as 1st spray of 250 mg/l at 30 days after sowing in nursery stage, 2nd spray SA @ 100 mg /lit at 30 DAT and 3rd spray SA @ 100 mg /lit at 45 DAT and 4th spray SA @ 100 mg /lit at 60 DAT was found beneficial for obtaining maximum yield, quality and storability of onion.

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