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Short Research Article

Effect of Salicylic Acid on Growth and Bulb Yield of Onion (*Allium Cepa* L.)

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Abstract

A field experiment was conducted under All India Network Research Project on Onion and Garlic operating at College of Horticulture (OUAT), Sambalpur, Odisha India during winter season of 2013–14 to study the efficacy of exogenous application of salicylic acid (SA) on growth and yield in onion var. Agrifound Light Red. The experiment was laid out in RBD with four replication having six treatments of different sprays of SA including control. The results revealed exogenous application of SA significantly increased the better vegetative growth in terms of plant height (68.18 to 71.08 cm), collar thickness (16.90 to 18.51 mm) with higher level of chlorophyll content of leaves (31.53 to 33.01 SPAD) than untreated control (61.71 cm, 15.29 mm, 26.77 SPAD, respectively). Further among different times of SA application, foliar spray of SA at 30 days after sowing (DAS) in nursery, 30 and 45 or 60 days after transplanting (DAT) recorded significantly maximum vegetative parameters than rest of spray schedule. Similar trend was also recorded for bulb yield and yield attributing parameters. Spraying of SA at 3 times had better efficacy than 2 times of spraying in terms of bulb diameter (polar: 65.60 to 67.94 mm and equitorial: 49.10 to 49.80 mm), bulb weight (59.50 to 69.25 g), marketable bulb yield (180.91 to 183.10 qha^{-1}) and total bulb yield (266.99 to 290.91 q ha^{-1}). Hence, it may be concluded that application of SA at 30 DAS, 30 DAT and/ or 45 or 60 DAT not only increased the vegetative growth but also bulb yield in onion variety ALR.

1. Introduction

Onion (*Allium cepa* L.) is one of the commercial vegetable and spice crops of India. India ranks 2nd position both in area (9.59 lakh ha) and production (163.09 lakh ton) with an average productivity of 17.01 t ha^{-1} in the world (FAOSTAT, 2013). In India, it is treated as most important export oriented vegetable, exporting to the tune of 1238102.6 tones of Rupees 230054.14 lakhs during 2014−2015 (Saxena et al., 2016). In India, onion is predominantly cultivated during *winter* (60%) followed by 20% each in *kharif* and late *kharif* season. The lower productivity of Indian onion is primarily due to cultivation of low yield potential varieties having susceptibility to both biotic (pests and diseases) as well as abiotic factors (i.e. moisture stress, high temperature, imbalance nutrition etc.). Commercial crops like onion are exposed to a wide array of damaging agents, including biotic (viroids, viruses, bacteria, fungi, insects) and abiotic (drought, salinity, heat, cold, soil toxicity) environmental aggressions. To cope with these continuous challenges under field conditions, plants have evolved broad and efficient mechanisms to obtain an adequate defense. One prominent defensive response of plants against pathogen attack is the synthesis of a remarkably vast array of low molecular weight compounds with disparate functions in plant-pathogen interactions (Dixon, 2001). Salicylic Acid (SA) recently included in the class of phytohormones for proper plant growth development and induction of tolerance to both biotic as well as abiotic stresses. In general, SA is an important defensive signal in plants that is essential for elicitor triggered immunity and the establishment of Systemic Acquired Resistance (SAR) (Carr et al*.,* 2010). Thus, SA is an endogenous growth regulator with phenolic nature, which participates in regulation of several physiological processes in crop plants such as stomata closure, ion uptake, inhibition of ethylene biosynthesis and transpiration (Khan et al*.,* 2003 and Shakirova et al*.,* 2003). In addition to its role towards biotic stresses, SA is also believed to play a key role in plant responses to many abiotic stresses such as ozone (Kochroo et

al., 2000), heat stress (Dat et al., 1998), chilling stress (Janda et al., 1999; Metwally et al., 2003), drought stress (Senaratna et al., 2000; Singh and Usha, 2003) etc.

As a whole, though these studies clearly suggests the involvement of SA in realization of different antistress functions in crop plants, but not much information was available on the efficacy of SA in one of the most important export oriented commercial vegetable crop of India, Onion. Keeping this in view, a field experiment was conducted under All India Network Research Project on Onion and Garlic operating at College of Horticulture (OUAT), Sambalpur, Odisha, India during winter seasons of 2013−14 to study about the effect of salicylic acid on growth and bulb yield of onion.

2. Materials and Methods

A field experiment was conducted during *rabi* season of 2013−14 under AINRP on Onion and Garlic at College of Horticulture, Chiplima, Sambalpur, Orissa University of Agriculture and Technology (OUAT), Odisha, India. Soil of the experiment area was sandy loam having pH of 5.4; available NPK 198.7:31.6:115.0 kg ha^{-1}. The field trial was laid out by adopting RBD replicated four with six treatments. The six treatment schedule consisting of foliar application of SA @ 250 mg l^{-1} at 30 days after sowing (DAS) followed by second spray either at 30 days after transplanting (DAT) (T_1), 45 DAT (T_2), 60 DAT (T_3) or foliar application of SA @ 250 mg L^{-1} at 30 DAS followed by 30 and 45 DAT (T_4), 30 and 60 DAT (T_5) along with an untreated control, without SA (T_6). Onion seeds variety Agrifound Light Red (ALR) obtained from the NHRDF, Nasik were sown in the nursery beds on 4.10.2013 at a distance of 5 cm and at a depth of 2 cm. The seedlings are sprayed with SA @ 250 mg L^{-1} of water at 30 DAS except the control treatment, as per the treatment schedule. About 55 days old seedling of 10−15 cm, height were transplanted in the field on 29.11.2013 at a spacing of 15×10 cm^2. All the recommended package of practices was adapted uniformly to all the treatments except the exogenous application of SA. The data recorded on various parameters were subjected to statistical analysis as per the procedure suggested by Sukhatme and Amble (1995).

3. Results and Discussion

3.1. Effect of SA on vegetative growth parameter

A perusal of Table 1 indicated signification variations in plant height due to application of different times of spraying of Salicylic Acid (SA) @ 250 mg L^{-1} observed at 75, 90 and 105 days after transplanting (DAT). During the three stages of crop growth, significantly maximum plant height was recorded in T_4, closely followed by T_2, T_3 and T_5, where statistical parity was observed. Similar trend was also observed in pooled results over three stages of crop growth. Regarding the collar thickness of onion plants, the results revealed significantly maximum collar thickness of 20.36 mm, 20.65 mm and 14.53 mm at 75, 90 and 105 DAT was recorded in T_5, closely followed by T_1, T_3 and T_4, where statistical parity was observed. Similar trend was also observed in pooled results over three stages of crop growth in onion.

Exogenous application of SA had a significant effect on chlorophyll content of leaves at three different stages of crop growth on 75, 90 and 105 DAT (Table 1). The results revealed significantly maximum chlorophyll content was recorded in T_5, followed by T_3 and T_4, where statistical parity was observed at three stages of crop growth. The data also showed significant influence on chlorophyll content of leaves in treatment, T_5 (33.01 SPAD) and T_4 (32.29 SPAD) than rest of the treatments pooled over the three stages of crop growth. Significantly lowest chlorophyll content of 26.77 SPAD was recorded in T_6.

Thus, the results of present study clearly demonstrated that SA at more times of spraying had significant effect than less

Table 1: Effect of SA on plant height (cm), collar thickness (mm) and chlorophyll content of leaves in onion var. ALR

Treatment	Plant height (cm) at				Collar thickness (mm) at				Chlorophyll (SPAD) content of leaves at			
	75 DAT	90 DAT	105 DAT	Mean	75 DAT	90 DAT	105 DAT	Mean	75 DAT	90 DAT	105 DAT	Mean
T_1	59.75	72.00	63.38	65.04	17.77	19.68	13.24	16.90	31.41	35.75	21.10	29.42
T_2	63.53	76.50	64.50	68.18	17.29	18.42	12.83	16.18	32.08	36.34	22.90	30.44
T_3	66.13	76.75	65.63	69.50	18.18	19.47	13.59	17.08	33.00	36.63	24.95	31.53
T_4	66.50	80.63	66.13	71.08	18.47	20.52	14.31	17.77	33.57	36.57	26.72	32.29
T_5	64.13	78.13	67.00	69.75	20.36	20.65	14.53	18.51	33.97	37.50	27.56	33.01
T_6	55.63	69.63	59.88	61.71	16.38	17.59	11.89	15.29	30.17	30.51	19.64	26.77
Mean	62.61	75.60	64.42	67.54	18.07	19.39	13.40	16.95	32.37	35.55	23.81	30.57
SEm±	2.29	3.32	2.05	1.77	1.11	0.82	0.79	0.71	1.01	0.48	0.48	0.48
CD (*p*=0.05)	4.89	7.07	4.37	3.78	2.36	1.75	1.69	1.51	2.16	1.03	1.02	1.02

DAT: Days After Transplanting; SPAD: SPAD-Values are commonly used to express the relative leaf chlorophyll content

number of spraying. The present study also clearly indicated the beneficial impact of SA on crop growth, which might be due to the involvement SA in regulation of several physiological processes in plants such as stomata closure, ion uptake, inhibition of biosynthesis and transpiration (Khan et al., 2003 and Shakirova et al., 2003). SA had also prolific effects on both morphology and physiology of plants (Piperpoint, 1996 and Poncheva et al., 1996). Exogenous application of SA had effect on increased photosynthetic activity which enhances the number of leaves plant^{-1} and chlorophyll content, there by plant height (Gharib, 2006). Similar reports on beneficial effects of SA on vegetative growth in form of plant height, number of leaves plant^{-1}, chlorophyll content of leaves have also been reported in several crops, such as El- Tayeb (2005) in chilli; Amin et al. (2007) in onion; Gawade and Sirohi (2011) in brinjal and Khandaner et al. (2011) in red amaranthus etc.

3.2. Effect of salicylic acid on bulb yield and yield attributing parameters

The results on yield attributing parameters of onion var. ALR revealed significant variations in onion bulb diameter (polar and equatorial) and average bulb weight due to application of different times of spraying of SA (Table 2). Significantly maximum polar diameter of 67.94 mm was recorded in T_5 than rest of the treatments, except T_3 and T_4, which were statistically at par. On the other hand, significantly maximum diameter of 49.80 mm was recorded in T_3 than control, T_6 (45.82 mm). However, statistical parity was recorded in all the treatments except T_1 for equatorial diameter of bulbs. The results also indicated that both the diameter (polar and equitorial) was significantly reduced in control plot, without application of SA. This might be due to better photosynthetic efficacy with SA application and increased chlorophyll content of leaves (Amin et al., 2007). The better efficacy of SA increasing the effective photosynthetic area in terms of plant height, number of leaves plant^{-1} and chlorophyll content significantly enhance the assimilation of photosynthates in the bulb. Results higher values of polar and equitorial diameter in onion bulbs were also reported by Amin et al. (2007) and that of garlic by Bideshki and Arvin (2010).

Table 2: Effect of SA on bulb diameter (mm), bulb weight (g) marketable and total bulb yield of onion

Treatment	Polar diameter (mm)	Equatorial diameter (mm)	Average bulb weight (g)	Marketable bulb yield (q ha^{-1})	Total bulb yield (q ha^{-1})
T_1	62.70	48.54	55.75	106.81	214.74
T_2	62.72	48.78	57.00	133.29	235.23
T_3	65.60	49.80	59.50	151.08	266.99
T_4	66.34	49.72	63.75	183.10	277.19
T_5	67.94	49.10	69.25	180.91	290.91
T_6	61.51	45.82	54.50	81.50	185.78
Mean	64.47	48.63	59.96	139.45	245.14
SEm±	1.77	1.21	4.61	12.23	13.55
CD (p=0.05)	3.78	2.57	9.83	26.06	28.88

Significantly heaviest bulb of 69.25 g was recorded in the treatment T_5 than rest of the treatments except T_3 (59.50 g) and T_4 (63.75 g) which were statistical at par. Significantly minimum bulb weight of 54.50 g was recorded in control plots, T_6. The increased bulb weight in the present study by application of SA might be due to the better utilization of photosynthates and increased allocation of photosynthates towards the economic parts, the bulb in onion. Several studies indicated that SA may have a dramatic effect on sugar metabolism in plants. Sugar–the form of simple carbohydrates are well known for its role in plant metabolism in all living cells (Hirabayashi, 1996). In general, both glucose and fructose are the primary sucrose of carbon and energy for plant cells. In oxygenic photosynthesis and is a transport molecule in plant growth development and storage (Couee et al., 2006). Similar report on better efficacy of SA over control was also reported in onion by Amin et al. (2007), garlic by Bideshki and Arvin (2010) and green pea by Hak et al. (2012).

The results presented on total bulb yield and marketable bulb yield of onion var. ALR revealed significant variations among different treatments due to exogenous application of SA (Table 2). The results revealed significantly highest total bulb yield of 290.91 q ha^{-1} in T_5 than rest of the treatments. However, statistically parity were observed with T_3 (266.99 q ha^{-1}) and T_4 (277.19 q ha^{-1}). Significantly highest marketable bulb yield of 183.10 q ha^{-1} was recorded in T_4, closely followed by T_5 (180.91 q ha^{-1}) than rest of the treatments. However, both T_4 and T_5 were statistically at par. Similar report of higher bulb yield in onion with application of SA than the control was also reported by Amin et al. (2007). The higher marketable bulb yield might be due to enhanced assimilation of nutrient uptake, nutrient reduction and photosynthesis improved flow assimilates and increased cell integrity which in term reflected on the increased bulb yield of the onion plants. Better efficacy of SA in garlic was also reported by Bideshki and Arvin (2010), which might be due to accumulation of more chlorophyll content in SA treated plants, responsible for the improved fresh and dry matter accumulation there by final bulb yield.

4. Conclusion

Foliar spray of Salicylic Acid (SA) is essential for onion crop. Foliar spray of SA @ 250 mg L^{-1} at 30 days after sowing during nursery seedling stage, subsequently second spray at 30 days after transplanting and third spray at either 45 or 60 days after

transplanting during crop growth stage not only increase the vegetative growth but also the bulb yield in onion var. ALR.

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