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Enhancement of yield by application of salicylic acid in two cotton varieties grown in semi-arid tropics of Nizamabad

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Abstract

The research experiments conducted on the role of salicylic acid (SA) sprayed in three concentrations viz., 0.5 mM, 1.0 mM and 3.0 mM on the yield in terms of buds/plant, flowers/plant, number of bolls/plant, boll weight, fibre length, number of seeds/plant, 100 seed weight and cotton seed oil contents of two varieties of cotton (*Gossypium herbaceum* L.) viz., *Bt*- cotton and non-*Bt* plants grown in the semi-arid tropics of Nizamabad was studied. Nizamabad district soil is known for its salinity and the black soil which is largely responsible for the drought and saline stresses which hampers plant growth and metabolism. Application of three concentrations of SA stimulated the yield of both *Bt*-cotton and non-*Bt* cotton varieties. The *Bt*-cotton variety showed better performance over non-*Bt* varieties. SA at 3.0 mM conc. was found most effective in increasing the yield of both cotton varieties of over 1.0mM SA, 0.5mM SA applications as well as untreated controls. The enhancement of yield in terms of buds/plant, flowers/plant, number of bolls/plant, boll weight, fibre length, number of seeds/plant, 100 seed weight and cotton seed oil contents in both cotton varieties is an indicator that SA mitigated the negative effect of the semi-arid conditions of the soils in Nizamabad district.

Keywords: *Bt*-Cotton; Nizamabad; Non-*Bt* cotton; Salicylic acid; Yield

1. Introduction

Phytohormones have an important role to play in mediating plant responses to abiotic stress. Plants have developed over the years a variety of physiological and biochemical mechanisms through which they survive under the stressful conditions [1]. In the recent times, other plant growth regulators (PGRs) like brassinosteroids [2], methyl jasmonates [3], salicylic acid [4], and strigolactones [5] exhibited the potentiality in modulating various aspects of plant growth and development as well as ameliorating plants from different stresses like high and low temperatures, salinity, different modes of light intensity, drought as well as flooding, heavy metals, and stresses caused by different biotic beings. Salicylic acid (SA) is a phenolic compound exhibiting its potentiality in improving plant growth and development when applied in less concentration and is now being considered as a potential PGR [4]. It is reported to play a significant role in modulating various aspects of plant growth and development and interact with other organisms and defend the plants exposed to environmental stresses and acts as endogenous signal molecule that is responsible for inducing abiotic stress tolerance in plants [6-9].

Nizamabad district of Telangana State is a semi-arid tropical dry and wet region which usually experiences inconsistent rainfall. The saline black soil is neutral to alkaline. The inhibited plant growth due to the saline and water deficient soil is a well-known fact. Cotton (*Gossypium herbaceum* L.) is a commercially grown crop across India. Cotton is cultivated for its fibre and oil in different parts of Telangana State. The usage of PGRs (plant growth hormones) is the on-going research and the need of the hour. The present research study is focussed on the role of a known PGR, salicylic acid (SA). The enhancement of yield by application of SA in two varieties of cotton (*Bt* and non *Bt*) grown in semi-arid tropics of Nizamabad District of Telangana State in India was carried out as mentioned below.

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2. Material and methods

Cotton (*Gossypium herbaceum* L.) seeds of Bt (NCS -863 Bt-2) was procured from and non-Bt(NCS 108-sunny) was procured from Nuziveedu Seed company Private Ltd., Gundlapochampally, Medchal, Rangareddy, Telangana State, India.

Salicylic acid (SD –fine) was procured from Dwarakmai Enterprise, Hyderabad, Telangana State, India.

The present research was carried out by showing cotton seeds in a field. Two varieties of cotton seeds (*Bt* and non-*Bt)* were sown in different rows in the field along with farmyard manure. Cotton plants were grown under natural day length. Salicylic Acid (SA) was supplemented in three different concentration levels viz., 0.5 mM, 1.0 mM and 3.0 mM on 40th, 50th and 60th day (from sowing) as foliar spray. The yield parameters of cotton were recorded in terms of number of buds/plant on 65th day, number of flowers/plant on the 75th day and number of bolls/plant, boll weight, fibre length, number of seeds/plant, 100 seed weight and cotton seed oil contents on the 100th day. The data is represented in terms of Mean ± S.E (n=9).

2.1. Yield Parameters

The number of buds/plants were recorded on the 65th day and the number of flowers/plants were recorded on the 75th day. The other yield parameters in terms of number of bolls/plants, boll weight, fibre length of bolls, number of seeds/bolls, 100 seed weight and cotton seed oil contents were recorded on 100th day. The bolls were carefully separated from the plant. The number of bolls per plant was recorded. The weights of the bolls were recorded using a meter balance. The weight of the bolls per plant was expressed in grams. The length of the fibre of cotton was measured employing a meter balance. The length of the cotton seed fibre was recorded in meters. The cotton bolls were shelled taking utmost care to remove the seeds. The primary care was to see that the seeds were not split and their testa or seed coat remained intact. The number of cotton seeds per boll were noted. The 100 seed weight per cotton plant was recorded employing a meter balance. The 100 seed weights of cotton plant were expressed in milligrams.

2.2. Cotton Seed oil Content

The extraction and estimation of cotton seed oil content was carried out at Indian Institute of Chemical Technology (IICT), Hyderabad. Soxhlet Method given by Raghuramalu *et al*. [10] was adapted. The oil present in the cotton seeds was analyzed as crude ether extract of the dry material. 10gms of seeds were powdered and carefully poured into a thimble. The thimble was plugged with cotton and carefully kept in a soxhlet apparatus for around sixteen hours to be extracted using anhydrous ether. The extracted ether was carefully poured into a weighted conical flask using a filter. The conical flask having the remnants of ether was then washed around five times with little amounts of ether which was again poured. Then the ether was evaporated. The conical flask containing the residue was oven dried at 1000 C, cooled in a desiccator and carefully weighed.

$$\text{Oil content } = \frac{W1}{W2}$$

Where W1= Weight of ether extracted; W2=Weight of the sample equivalent to fresh sample taken. The cotton seed oil content was expressed in g/100g of the original material.

3. Results

The effect of SA on the number of buds/plant and number of flowers/plant in two varieties of cotton (*Bt* and non - *Bt*) grown in semi-arid tropics of Nizamabad is shown in Table 1. The results obtained in the present study clearly indicate substantial increase in number of buds/ cotton plants as well as and number of flowers/plant. All the three concentrations of SA viz., 0.5mM, 1.0mM and 3.0mM increased number of buds/cotton plant and number of flowers/cotton plant in both the *Bt* and non-*Bt* varieties grown in semi-arid soils of Nizamabad over control plants. SA at 3.0mM was found most effective in substantial increases in number of buds/cotton plant ad and number of flowers/ cotton plant compared to the other two concentrations as well as control plants. The *Bt* variety of cotton plants showed enhanced number of buds/cotton plant and number of flowers/ cotton plant over non-*Bt* and controls.

The effect of SA on the number of bolls/cotton plant and boll weight of two varieties of cotton (*Bt* and non- *Bt*) grown in semi-arid tropics of Nizamabad is shown in Table 1. The results obtained in the present study clearly indicate substantial increase in number of bolls/cotton plant and boll weight of cotton plants. All the three concentrations of SA

viz., 0.5mM, 1.0mM and 3.0mM increased the number of bolls/cotton plant and boll weight of both the *Bt* and non-*Bt* varieties of cotton plants grown in semi-arid soils of Nizamabad over control plants. SA at 3.0mM was found most effective in substantial increase in number of bolls/cotton plant and boll weight compared to the other two concentrations as well as control plants. The *Bt* variety of cotton plants showed enhanced yield

Table 1 Effect of salicylic acid on buds/plant, flowers/plant, bolls/plant and boll weight of two varieties of cotton (*Bt* and non *Bt*) plants grown in semi-arid tropics of Nizamabad

Varieties	Treatments	Number of (buds/plant) *	(Number of flowers/plant) *	Number of bolls/plant)*	Boll weight(gm)*
Non -*Bt* cotton	0.5 mM SA	5.23±0.597	5.33 ± 0.89	13.66 ± 0.88	4.80 ± 0.55
	1.0 mM SA	6.11±0.597	6.23 ± 0.8	15.00 ± 0.57	5.26 ± 0.66
	3.0 mM SA	7.63±1.287	7.66 ± 0.91	16.33 ± 0.66	6.43 ± 0.60
	Control	4.55±0.495	4.40 ± 0.73	7.08 ± 0.57	4.40 ± 0.51
Bt cotton	0.5 mM SA	5.33±0.868	5.63 ± 0.77	12.33 ± 0.33	4.88 ± 0.40
	1.0 mM SA	6.66±0.970	6.53 ± 1.07	14.66 ± 0.66	5.43 ± 0.40
	3.0 mM SA	7.88±0.972	7.93 ± 0.70	17.33 ± 0.88	6.82 ± 0.40
	Control	4.88±0.597	4.88 ± 0.70	7.33 ± 0.88	4.53 ± 0.20

The effect of SA on in the seed fibre length, Number of seeds/plant, fibre length, number of seeds/plant, 100 seed weight and cotton seed oil contents of two varieties of cotton (Bt and non Bt) grown in semi-arid tropics of Nizamabad control is shown in Table 2. All the concentrations viz., 0.5mM, 1.0mM, 3.0mM uniformly accounted for steep increments in seed fibre length, Number of seeds/plant, fibre length, number of seeds/plant, 100 seed weight and cotton seed oil contents of the cotton plant where in 3.0mM SA concentration recorded maximum increments in both *Bt* and non - *Bt* varieties of cotton though the *Bt* variety of cotton plants showed enhanced effect over non-*Bt* and controls.

Table 2 Effect of salicylic acid on the fibre length, seeds/plant,100 seed weight and cotton seed oil content of two varieties of cotton (*Bt* and Non - *Bt*) plants grown in semi-arid tropics of Nizamabad

Varieties	Treatments	Fibre length (cm)*	*Seeds/plant	100 Seed weight (gm)*	Cotton seed oil content(ml)*
Non - *Bt* cotton	0.5 mM SA	9.32 ± 0.37	321.33 ± 0.66	12.00 ± 1.15	1673 ± 1.33
	1.0 mM SA	10.63 ± 0.35	371.33 ± 1.76	15.66 ± 0.88	1715 ± 0.57
	3.0 mM SA	11.53 ± 0.29	388.33 ± 0.88	16.33 ± 0.88	1780 ± 1.15
	Control	8.10 ± 0.36	284.66 ± 0.66	10.00 ± 0.57	1602 ± 0.66
Bt cotton	0.5 mM SA	9.86 ± 0.38	344.33 ± 0.33	13.00 ± 0.57	1685 ± 0.33
	1.0 mM SA	10.93 ± 0.29	382.66 ± 1.76	15.33 ± 0.88	1730 ± 0.57
	3.0 mM SA	11.99 ± 0.40	418.00 ± 1.15	16.33 ± 1.20	1798 ± 0.33
	Control	8.63 ± 0.44	296.33 ± 0.33	10.00 ± 0.57	1620 ± 0.33

4. Discussion

The effect of exogenous application of SA on growth depends on the various aspects of plants viz., developmental stages, time of application and SA concentrations. Growth-stimulating effects of SA have been reported in wheat [9], maize [11], and chamomile [12]. Earlier works depicted the ability of SA in improving the yield in different plant species under normal as well as stressful conditions.

Abreu & Munné-Bosch [13] reported that of salicylic acid application increased seed yield in the annual plant, *Arabidopsis thaliana.* Application of SA not only increased the yield in Huang Kum pear but also prevented the premature loss of fruits [14]. Singh et al. [15] observed that application of 500, 1000, 2000 and 4000 ppm of SA at flower bud differentiation stage in two cultivars of mango viz., Amrapali and Dashehari resulted in promotion of flowering, fruit set as well as yield in both cultivars. Further, the floral malformation of was also found reduced [15]. Foliar application of 2000 ppm salicylic acid to mango exhibited a greater number of both male (1035) and hermaphrodite flowers (335) per panicle, maximum fruit retention per panicle at harvest time was recorded in trees [16]. Even the fruit weight, number of fruits per tree and yield of mango were significantly influenced due to the application of different concentrations of salicylic acid.

5. Conclusion

The present study reveals that the ability of yield improvement in terms buds/plant and flowers/plant, bolls/plant, boll weight, fibre length seeds/plant, 100 seed weight and as well as the content of cotton seed oil when SA was supplied as foliar spray to *Bt* and non-*Bt* varieties of cotton plants grown in semi-arid soils of Nizamabad by overcoming the negative effect of the semi-arid conditions of the soil (reflected in the control plants).

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict of interest.

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