



Effect of Foliarly-treated Salicylic Acid on the Yield of *Pennisetum glaucum* L.

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Pennisetum glaucum L. is an important cereal crop in the world with multiple functions as a staple food, feed, fodder and good source of energy. The phytohormone, salicylic acid (SA) plays an essential role in the improvement of productivity in *Pennisetum glaucum* (L.) commonly called as bajra. Foliar exogenous application of SA is a simple and effective way to improve the yield in the number, size and weight of *Pennisetum glaucum* seeds. The treatment of bajra plants with 3.0 mM salicylic acid (SA) increased the size, weight and number of seeds per single panicle and elevated productivity. With the present study, it was proven that SA application was associated with the enhancement of productivity in bajra and the data suggests that SA - application induced enhancement of productivity of bajra grown in drought - stressed regions of Telangana.

Keywords: Bajra; panicle; salicylic acid; seed weight; yield.

1. INTRODUCTION

Bajra or *Pennisetum glaucum* (L.) R. Br., belongs to the grass (Poaceae) family, is cosmopolitan in distribution and is widely cultivated in different parts of the world though it is native to West

Africa. It is widely cultivated in tropical areas for its edible grains, stover, and fodder in various parts of the globe. The germplasm of both cultivated and wild bajra is conserved as 66,682 accessions in 97 gene banks in around 65 countries [1]. Bajra is a predominant grain cereal

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and forage crop of the Indian subcontinent and African regions. Bajra is one of the sixth most important cereal crops in the world production after wheat (*Triticum aestivum* L.), rice (*Oryza sativa* L.), maize (*Zea mays* L.), barley (*Hordeum vulgare* L.) and sorghum (*Sorghum bicolor* (L.) Moench). It is the second most sought - after millet after sorghum. Bajra is the most widely grown staple food crop of majority of the poor and small landholders in Asia and Africa and can be cultivated in sandy soils even in dry conditions [2]. In India, bajra is the fourth most widely cultivated food crop after rice, wheat and maize. It occupies nearly 7.4 million hectares with an average production of 9.13 million tonnes and productivity of 1237 kg/ha from 2017-2018 as reported by Directorate of Millets Development in 2019. The major bajra growing states in India are Rajasthan, Maharashtra, Uttar Pradesh, Gujarat and Haryana which produce nearly 90% of the total production of the country.

Bajra is a good source of energy as it comprises of carbohydrates, fat, dietary fibre, vitamins, fatty acids, fibres, iron and zinc and thus is a staple food for millions of people. It generally comprises of 9-13% protein, though a large variation exists among genotypes wherein proteins ranging from 6-21% have been observed [3]. It is high in fibre around 1.2 g/100g and shows alpha-amylase activity when compared with other grains.

Salicylic acid (SA) is an organic compound which is water phobic in nature and is a phenolic compound that participates in the regulation of cell suspension cultures [4], the flowering [5], seed germination [6], sulphur and nitrogen metabolism [7], photosynthesis [8] proline metabolism [9] etc. Application or supplementation of SA resulted in mitigating different abiotic stresses in plants such as drought [10-12], chilling [13-14], salinity stress [15-17], heavy metal tolerance [18-19], heat [20], UV radiation [21] etc. SA can be supplemented to plants by foliar application [22] and soil treatment [23]. It was found effective even when supplied by hydroponically [24]. In the present study, bajra seeds were used to investigate the yield quantity in the drought - stressed regions of Telangana which is one of the most important crops all over the world. The present study was conducted to understand and quantify the effect of foliarly-treated salicylic acid (SA) on the yield of bajra grown in drought - stressed Telangana State, India.

2. MATERIALS AND METHODS

Bajra seeds were procured from National Seeds Corporation, Madikonda, Warangal Urban district, Telangana State, India during the *Kharif* - 2014 and *Rabi* - 2015 seasons. One popularly used local variety of seeds viz., *Ananta* was employed in the present experiment work. SA (SD-fine) was procured from Dwarakamai Enterprises located in Hyderabad of Telangana State, India. Individual plots were prepared with a size of 10x10 m. The plots were uniformly mixed with twenty five kilograms of conventional compost. The bajra plants were grown in field (10x100 m - length and width) containing fresh sieved reddish soil mixed with organic manure. The seeds of bajra viz., variety *Ananta* were surface first sterilized with 0.5% (v/v) sodium hypochlorite and washed carefully with several changes of sterile distilled water to remove any additional sodium hypochlorite adhering to them. They were immersed for 24h in *Rhizobium* inoculums. Thirty Seeds of bajra were sown in each row keeping a gap of about 40 cm between each row and a total of twelve rows (treated nine rows for three different concentrations of SA and three rows as controls) were prepared in the field and totally 630 seeds were sown in 10x10 m well prepared plot. Germination of bajra seeds started around 3-4 days after sowing. On the 7th day (3-4 leaves stage) after the germination, approximately 75% of plants (ca. 470 individuals) were retained in the soil. Bajra crops were grown under natural day length and observed initiation of panicle in 4th week (22nd day onwards). Salicylic acid (SA) was supplied at six different concentrations viz., 0.5 mM, 1.0 mM, 2.0 mM, 3.0 mM, 3.5mM and 4.0 mM and three rows (total nine rows) were maintained for each concentration of SA in the bajra field. Three rows were maintained as controls which were supplemented with water. SA was supplemented as foliar spray to bajra crop and the spraying was done in the wee hours of the morning by using sprayers. Foliar application of SA was done thrice to bajra plants on 20th, 40th and 50th (from the day of sowing of seeds) whereas the untreated bajra controls were supplied with distilled water. The results presented are the mean values of 9 replicates. One-way analysis of variance (ANOVA) was carried out and the differences were considered significant if p was ≤ 0.05 .

3. RESULTS

The effect of six concentrations of salicylic acid (SA) viz., 0.5 mM SA, 1.0 mM SA, 2.0 mM SA,

3.0mM SA, 3.5 mM SA and 4.0 mM SA on the reproductive growth were quantified as panicles/plant and length of panicle of bajra.

3.1 Number of Panicles/Plant

Application of 3.0 mM concentration of SA caused a maximum raise in the production of a

number of panicles in bajra plants around 202.91%, followed by 2.0 mM concentration of SA which caused a raise of 186.41%, followed by 1.0 mM conc. of SA which caused an increase of 136.89% and 0.5 mM conc. of SA which caused an increase of 86.41% over water-treated control plants (Plate 1 & Fig. 1).

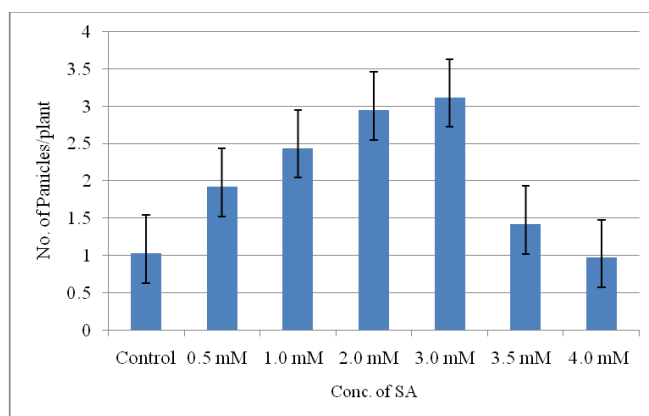


Fig. 1. Effect of Salicylic Acid (SA) on the Number of Panicles/Plant (65th Day from Sowing) of Bajra Grown in Drought –Stressed Telangana State

*The results presented are the mean values of 9 replicates. One-way analysis of variance (ANOVA) was carried out and the differences were considered significant if p was ≤ 0.05



Plate 1. Length of Bajra Plants and Panicles after the Application of Salicylic Acid in Six Different Concentrations. (A) Depicting Plant Height; (B) & (C) Depicting Length of Panicles

3.2 Length of Panicle

Treatment of 3.0 mM concentration of SA caused a maximum hike in the length of panicles in bajra plants around 48.52%, followed by 2.0 mM concentration of SA which caused a hike of 25.05%, followed by 1.0 mM conc. of SA which caused a hike of 19.88% and 0.5 mM conc. of SA which caused a hike of 14.61% over untreated control plants. The treatment of the other two concentrations of SA viz., 3.5 mM and 4.0 mM depicted diminished length of panicles in bajra compared to the other four treatments mentioned above. Treatment of 3.5 mM concentration of SA caused a slight hike of around 2.73% whereas 4.0 mM concentration of SA caused a diminution of around 12.79% in panicle length compared to water - treated controls (Fig. 2).

The effect of six different concentrations of salicylic acid (SA) viz., 0.5mM, 1.0mM, 2.0 mM, 3.0 mM, 3.5 mM and 4.0mM on the yield of bajra was quantified as the number of seeds/panicle and 1000 seeds weight on the 85th day after sowing.

3.3 Seeds/Panicle

The foliar application of six concentrations of salicylic acid (SA) viz., 0.5 mM, 1.0 mM, 2.0 mM, 3.0 mM, 3.5 mM and 4.0 mM did not show same result patterns (Fig. 3). Application of 3.0 mM concentration of SA caused a maximum surge in the production of number of seeds per a panicle

in bajra plants around 51.86%, followed by 2.0 mM concentration of SA which caused a surge of 43.19%, followed by 1.0 mM conc. of SA which caused a surge of 37.52% and 0.5 mM conc. of SA which caused a surge of 11.80% over untreated control plants.

The application of the other two concentrations of SA viz., 3.5 mM and 4.0 mM depicted varying patterns not following the gradual surging. Application of 3.5 mM concentration of SA caused a slight surge of 5.64% but application of 4.0 mM concentration of SA resulted in reduced number of seeds per a panicle by 11.81% in bajra plants.

3.4 1000 Seed Weight

The four treatments of salicylic acid (SA) viz., 0.5 mM, 1.0 mM, 2.0 mM and 3.0 mM substantially raised the 1000 seed weight per panicle in bajra plants (Fig. 4). Treatment of 3.0 mM concentration of SA caused a maximum enhancement in the seed weight in bajra plants around 52.84%, followed by 2.0 mM concentration of SA which caused an enhancement of 39.18%, followed by 1.0 mM conc. of SA which caused an enhancement of 32.9% and 0.5 mM conc. of SA which caused an enhancement of 22.23% over untreated control plants. The treatment of the above four concentrations of SA viz., 0.5 mM, 1.0 mM, 2.0 mM and 3.0 mM resulted in better 1000 seed weight in bajra plants.

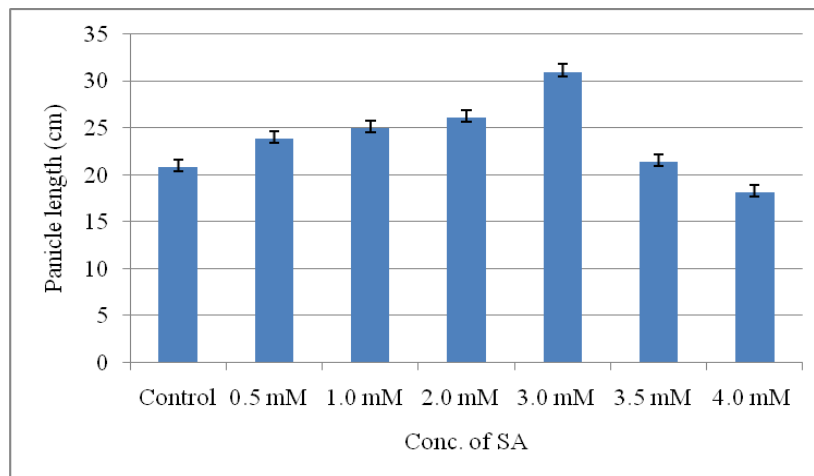


Fig. 2. Effect of Salicylic Acid (SA) on the Length of Panicle (65th Day from Sowing) of Bajra Grown in Drought –Stressed Telangana Stat

**The results presented are the mean values of 9 replicates. One-way analysis of variance (ANOVA) was carried out and the differences were considered significant if p was ≤ 0.05*

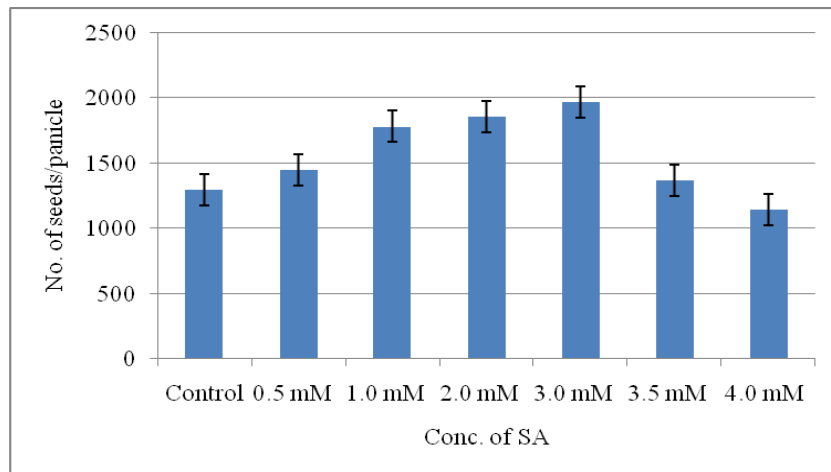


Fig. 3. Effect of Salicylic Acid (SA) on the Seeds/ Panicles (85th Day from Sowing) of Bajra Grown in Drought –Stressed Telangana State

*The results presented are the mean values of 9 replicates. One-way analysis of variance (ANOVA) was carried out and the differences were considered significant if p was ≤ 0.05

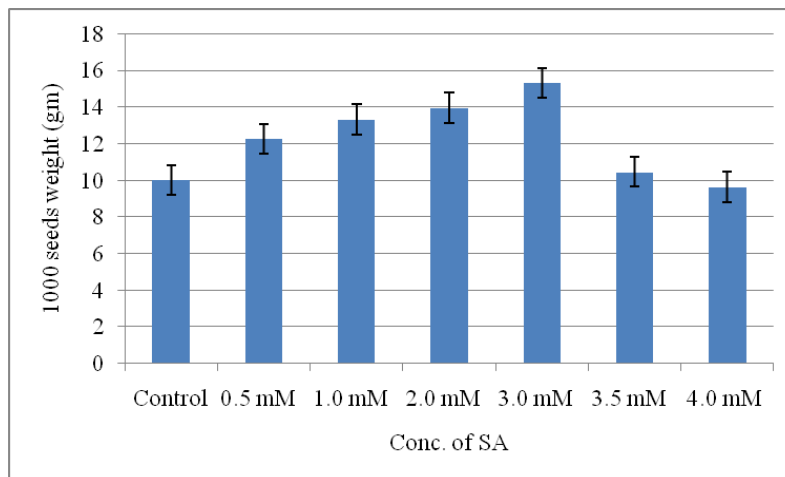


Fig. 4. Effect of Salicylic Acid (SA) on the 1000 Seed Weight (85th Day from Sowing) of Bajra

*The results presented are the mean values of 9 replicates. One-way analysis of variance (ANOVA) was carried out and the differences were considered significant if p was ≤ 0.05

The application of the other two concentrations of SA viz., 3.5 mM and 4.0 mM depicted in the gradual reduction of 1000 seed weight in bajra plants compared to the above - mentioned treatments. Application of 3.5 mM concentration of SA caused a slight increment of 4.39% but 4.0 mM concentration of SA caused a decline in the 1000 seed weight of bajra crop by 3.89%.

4. DISCUSSION

The present research study focusses on the application of salicylic acid (SA) on the yields of bajra plant. Earlier researchers also observed the potentiality of SA in the improvement of crop growth and yield. Asghari and Aghdam [25]

observed that exogenous treatment of SA increased fruit formation and overall productivity in different horticultural plants. Abdel-Salam [26] opined that exogenous application of SA in combination with few micronutrients to grapevine depicted improved yield parameters like cluster weight, berry weight and quantity of berry juice. Application of SA alleviated the salinity stress of *Rosmarinus officinalis* L. by modifying the chemical composition, gene expression and bioactivity of plant secondary metabolites in terms of specific major essential oils components causing reductions in α -pinene, β -pinene, and cineole along with sharp increases in linalool, camphor, borneol, and verbenone [27]. Tahjib-Ul-Arif et al [28] reported that exogenous treatment

of SA enhanced the yield parameters in *Zea mays* L. by enhancement of photosynthetic attributes and antioxidant capacity. Mohamed et al. [29] observed the effect of salicylic acid foliar spray at 3 mM concentration level which increased the vegetative growth and the number of flower clusters in strawberry (*Fragaria x ananassa* Duch) cultivars, and different studies were also proved the yield increases in many plant species after exogenous application of salicylic acid [30-33].

5. CONCLUSION

The foliar application of six different concentrations of salicylic acid (SA) viz., 0.5 mM, 1.0 mM, 2.0 mM, 3.0 mM, 3.5 mM and 4.0 mM did not depict similar result patterns on the yield of bajra quantified in terms of number of seeds/panicle and 1000 seeds weight. Four out of the six treatments of salicylic acid (SA) viz., 0.5 mM, 1.0 mM, 2.0 mM and 3.0 mM substantially surged the production of the yield (number of seeds/panicle and 1000 seeds weight of bajra but 3.5 mM and 4.0 mM of SA exhibited varying patterns. Application of 3.5 mM concentration of SA caused a slight surge but 4.0 mM concentration of SA caused a decrease in yield of bajra plants.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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