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Impact of antistress substances on growth and yield of watermelon under moisture stress conditions

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Abstract
A field experiment was carried out in polyhouse at College of Horticulture, Dr. YSRHU-Anantharajupeta, Andhra Pradesh during *rabi* season of the year 2023 to study the effect of antistress substances on growth and yield of watermelon during moisture stress conditions. The experimental design employed is split plot with three main plots and five subplots replicated thrice. The outcomes of the research revealed that spraying of Homobrassinolide @ 3ml/l at no moisture stress showed maximum vinelength, chlorophyll content and fruit yield per hectare. While minimum sex ratio and maximum no. of fruits were recorded under Salicylic acid spray @ 200 ppm at no moisture stress conditions. Even when subjected to 7 days moisture stress at 50 % flowering period, the application of Homobrassinolide at a concentration of 3 ml/l substantially increased fruit yield, superior to that achieved with sodium nitrophenolate and control, even in the absence of stress conditions.

Keywords: Antistress chemicals, moisture stress conditions

Introduction
Watermelon (*Citrullus lanatus*) is one of the most important fruits growing in tropical and subtropical areas. It is native to tropical areas of Africa near to Kalahari Desert and is a member of the cucurbitaceous family. In other parts of the world it also referred as tarbuj, kalingad and kalindi. Botanically the type of fruit is pepo, with a thick rind and fleshy centre. Moreover, melons are sweet, juicy and pleasant fruits. It is frequently consumed as a summer fruit due to its cooling properties, delicate flavour and high water content.

This summer crop holds significant economic and nutritional importance (Guo *et al.*, 2011)[1]. This crop requires a significant amount of water because it has a large leaf surface area and its fruits have a high water content. Therefore, irrigation plays a pivotal role in its cultivation, particularly during the fruit development stage (Kaya *et al.*, 2003) [2]. When water availability is limited, it can lead to delayed vine elongation, reduced leaf expansion and the shedding of flowers and fruits. Prolonged drought conditions can also result in a significant reduction in fruit yield.

Water stress is a significant challenge in arid and semi-arid regions. The scarcity of water hampers a majority of plant physiological processes, including photosynthesis, cellular development and nutrient transport. When faced with water stress, plants can respond in either a susceptible or tolerant manner, which depends on a complex interplay of physiological, biochemical and morphological factors (Panella *et al.*, 2014) [3]. While plants have natural mechanisms to alleviate the impacts of drought stress such as increased root growth, enhanced antioxidant enzyme activity and the accumulation of compatible solutes, there has been an effort to identify certain antistress substances that can further enhance the natural drought tolerance of plants and promote their healthy growth.

Antistress substances play a crucial role as supplements to nutrients and can have a significant influence, particularly in abiotic stress conditions, especially water stress. The application of antistress substances has the potential to reduce the plant's transpiration rate and improve Water Use Efficiency (WUE). Hence, the present study was undertaken to investigate the impact of foliar application of various antistress substances on the growth and yield of watermelon under varying moisture stress conditions.

Material and Methods
The present investigation was conducted during *rabi* 2023 at Horticultural Research Station,

Anantharajupeta, Annamayya district, Andhra Pradesh. The experiment was laid out in Split plot design with three main plots and five subplots replicated thrice. The main plots comprised of 3 moisture stress conditions *viz.*, M_1-No moisture stress, M_2-7 days moisture stress during 50 % flowering period and M_3-14 days moisture stress during 50 % flowering period. Subplot treatments includes S_1-Control, S_2-Salicylic acid @ 200 ppm, S_3- Homobrassinolide @ 3 ml/l, S_4-Sodium nitrophenolate @ 0.3% and S_5-Potassium silicate @ 3 g/l. No of sprays: 3, These Chemical sprays will be given at 3 stages 1. Early runner phase (Approximately at 20 DAS), 2. During flowering (Approximately at 30-35 DAS) and 3. When the fruit was about to 50 mm in size (Approximately 50-55 DAS)

Results and Discussion

Growth and yield parameters

Vinelength

The data in the table 1 revealed that vinelength was significantly varied among antistress chemicals, moisture stress conditions and their interactions. Application of HBL @ 3 ml/l recorded maximum vine length (3.06 m) recorded in which was comparable with S_4 (SNP @ 0.3%) (2.94 m). Meanwhile the lowest vine length (2.57 m) was recorded in the S_1 (Control). With respect to different moisture stress conditions M_1 (No moisture stress) recorded maximum vine length (2.91 m). However M_3 (14 days moisture stress during 50% flowering) recorded the lowest vine length (2.82 m). Among the interaction response the treatment combination M_1S_3 (HBL @ 3 ml/l at no moisture stress) (3.22 m) recorded highest vine length. While the lowest vine lengths (2.52 m) and (2.58 m) was recorded in M_3S_1 (Control at 14 days moisture stress during 50% flowering) and M_1S_1 (Control at no moisture stress) respectively.

Sex ratio

The data recorded in table 2 exhibited that the sex ratio was influenced by antistress chemicals, moisture stress conditions and their interactions. The least sex ratios were recorded under the S_2 (SA @ 200 ppm) (7.73) and S_5 (PS @ 3 g/l) (7.79). The maximum sex ratio (8.56) was observed in S_1 (Control). Among different moisture stress conditions M_1 (No moisture stress) recorded lowest sex ratio (7.45). While the highest sex ratio (8.91) was observed in M_3 (14 days moisture stress during 50% flowering). With regard to treatment combinations the least sex ratios (7.20) were recorded under both the treatments M_1S_2 (SA @ 200 ppm at no moisture stress) and M_2S_2 (SA @ 200 ppm at 7 days moisture stress during 50% flowering). However, the maximum sex ratios (9.80 and 9.00) were recorded under M_3S_1 (Control at 14 days moisture stress during 50% flowering) and M_3S_4 (SNP @ 0.3 % at 14 days moisture stress during 50% flowering).

Chlorophyll content

The data presented in table 3 shows the impact of antistress chemicals and moisture stress conditions on chlorophyll content. The application of Homobrassinolide @ 3 ml/l recorded maximum chlorophyll content (2.84 mg g^{-1}) which was statistically superior to all other treatments. While the minimum chlorophyll content (2.03 mg g^{-1}) was recorded under S_1 (Control). Whereas, under stress conditions the maximum and minimum chlorophyll contents (2.66 and 2.45 mg g^{-1}) were observed under M_1 (No moisture stress) and M_3 (14 days moisture stress during 50% flowering) respectively.

No. of fruits per plant

The data presented in table 4 represents the number of fruits per plant was influenced by the different antistress chemicals and moisture stress conditions. In general, present study showed that among different antistress chemicals used, the treatment S_2 (SA @ 200 ppm) (2.37) recorded maximum no. of fruits per plant which was statistically comparable with S_3 (HBL @ 3 ml/l) (2.26) whereas S_1 (Control) (1.75) recorded minimum no. of fruits per plant. Whereas among different moisture stress conditions studied, the treatment M_1 (No moisture stress) (2.43) observed maximum no. of fruits per plant. While M_3 (14 days moisture stress during 50% flowering) (1.73) recorded minimum no. of fruits per plant. Among various treatment combination M_1S_2 (SA @ 200 ppm at no moisture stress) (2.62) noticed maximum no. of fruits per plant which was comparable with M_1S_3 (HBL @ 3 ml/l at no moisture stress) (2.58) M_2S_2 (SA @ 200 ppm at 7 days moisture stress during 50% flowering period) (2.56) and M_1S_5 (PS @ 3 g/l at no moisture stress) (2.46). Whereas M_3S_1 (Control at 14 days moisture stress during 50% flowering) (1.40) recorded minimum no. of fruits per plant compared with all other treatments.

Fruit yield per hectare (t/ha)

The data was presented in table 5 shows that fruit yield per hectare was influenced by the different antistress chemicals, moisture stress conditions and their interactions. Application of Homobrassinolide @ 3 ml/l recorded maximum fruit yield per hectare (45.96 t/ha). Whereas the lowest fruit yield per hectare was observed in S_1 (Control) (28.56 t/ha). Among different moisture stress conditions M_1 (No moisture stress) recorded maximum fruit yield per hectare (47.37 t/ha) whereas M_3 (14 days moisture stress during 50% flowering) (28.42 t/ha) noticed minimum fruit yield per hectare. Among different treatment combination M_1S_3 (HBL @ 3 ml/l at no moisture stress) (56.64 t/ha) recorded higher fruit yield per hectare. Whereas, lowest fruit yield (20.16 t/ha) was recorded in M_3S_1 (Control at 14 days moisture stress during 50% flowering).

Table 1. Impact of antistress substances on vinelength (m) of watermelon cv. Arka Shyama at different moisture stress conditions

Moisture stress	Vine length (m)					
	Antistress chemicals					
	S_1	S_2	S_3	S_4	S_5	Mean
M_1	2.58	2.86	3.22	2.95	2.94	2.91
M_2	2.61	2.66	3.02	2.96	2.89	2.83
M_3	2.52	2.83	2.93	2.93	2.87	2.82
Mean	2.57	2.78	3.06	2.94	2.90	
Factors	CD at 5%			SE m±		
M	0.07			0.01		
S	0.07			0.02		
S at M	0.14			0.04		
M at S	0.14			0.04		

Table 2: Impact of antistress substance1s on sex ratio of watermelon cv. Arka Shyama at different moisture stress conditions

Moisture stress	Sex ratio					
	Antistress chemicals					
	S_1	S_2	S_3	S_4	S_5	Mean
M_1	7.69	7.20	7.40	7.60	7.39	7.45
M_2	8.20	7.20	7.70	8.30	7.59	7.80
M_3	9.80	8.79	8.60	9.00	8.40	8.91
Mean	8.56	7.73	7.90	8.30	7.79	
Factors	CD at 5%			SE m±		
M	0.15			0.03		
S	0.17			0.06		
S at M	0.32			0.08		
M at S	0.31			0.10		

Table 3. Impact of antistress substances on chlorophyll content (mg g^{-1}) of watermelon cv. Arka Shyama at different moisture stress conditions

Moisture stress	Chlorophyll content (mg g^{-1})					
	Antistress chemicals					
	S_1	S_2	S_3	S_4	S_5	Mean
M_1	2.14	2.89	2.93	2.67	2.65	2.66
M_2	2.03	2.76	2.80	2.43	2.53	2.51
M_3	1.92	2.70	2.78	2.38	2.48	2.45
Mean	2.03	2.78	2.84	2.49	2.55	
Factors	CD at 5%			SE m±		
M	0.06			0.01		
S	0.04			0.01		
S at M	NS			0.03		
M at S	NS			0.03		

Table 4: Impact of antistress substances on no. of fruits per plant of watermelon cv. Arka Shyama at different moisture stress conditions

Moisture stress	No. of fruits per plant					
	Antistress chemicals					
	S_1	S_2	S_3	S_4	S_5	Mean M
M_1	2.20	2.62	2.58	2.33	2.46	2.43
M_2	1.66	2.56	2.36	2.26	2.26	2.20
M_3	1.40	1.93	1.86	1.66	1.80	1.73
Mean S	1.75	2.37	2.26	2.08	2.17	
Factors	CD at 5%			SE m±		
M	0.14			0.03		
S	0.12			0.04		
S at M	0.23			0.07		
M at S	0.23			0.07		

Table 5: Impact of antistress substances on fruit yield per hectare (kg) of watermelon cv. Arka Shyama at different moisture stress conditions

Moisture stress	Fruit yieldper hectare (kg)					
	Antistress chemicals					
	S_1	S_2	S_3	S_4	S_5	Mean
M_1	37.92	49.20	56.64	44.40	48.72	47.37
M_2	27.60	45.84	48.24	38.64	40.80	40.22
M_3	20.16	32.04	33.02	27.60	29.28	28.42
Mean	28.56	42.36	45.96	36.88	39.60	
Factors	CD at 5%			SE m±		
M	1.83			0.45		
S	1.02			0.35		
S at M	2.05			1.01		
M at S	2.39			0.70		

Discussion
The treatment involving homobrassinolide resulted in significantly highest vine length. It might be due to increase in the cellwall flexibility, followed by hydrolysis of starch into sugars, which reduces the water potential of the cell, resulting in the entry of water into the cell and thereby inducing elongation Sargent (1965) [4]. The treatment involving salicylic acid exhibited the lowest sex ratio, which could possibly be attributed to the reduction in the production of 1-aminocyclopropane-1-carboxylic acid (ACC). This compound is a precursor to ethylene production in plants, as observed in tomato (Li *et al.*, 1992) [6]. Water deficit leads to a decline in chlorophyll content due to both damage to chloroplast structure and a reduction in chlorophyll biosynthesis (Wang *et al.*, 2010) [5]. This decrease in chlorophyll during stress could result from the activation of proteolytic enzymes like chlorophyllase, which is responsible for chlorophyll degradation (Sabater and Rodriquez, 1978) [7], as well as damage to the photosynthetic apparatus. In contrast, plants treated with salicylic acid synthesized more cytokinins (Sakhabutdinova *et al.*, 2003) [8], which in turn promoted chloroplast differentiation, chlorophyll biosynthesis and prevent chlorophyll degradation (Fletcher *et al.*, 1982) [12]. Similar results were reported by Korkmaz *et al.* (2007) [11] in muskmelon, Baninasab (2010) in cucumber and Sibomana *et al*. (2013) [9] in tomato. The increased yield attributed to the application of Homobrassinolide is likely due to its promotion of proline synthesis in stressful conditions, thereby enhancing stress tolerance. Furthermore, it also plays a crucial role in enhancing fruit ripening, elevating fruit quality and ultimately increasing fruit yield. Similar results were reported in watermelon (Ikekawa and Nagai in 1987) [10].

Conclusion
Among the five different antistress chemicals examined, treatment S_3 (HBL @ 3ml/l) consistently displayed the highest values for various growth, physiological, fruit, biochemical enzyme and quality parameters. It ranked first, followed by salicylic acid, which ranked second in terms of these measured attributes. Between the two moisture stress conditions assessed, treatment M2 (7 days moisture stress during 50% flowering period) consistently exhibited superior values across various growth, physiological, fruit, biochemical enzyme and quality parameters when compared to the treatment with a 14 days stress period. Nevertheless, it's worth noting that both of these treatments yielded significantly lower results compared to the control treatment, where no stress was applied.

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