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Effect of Salicylic Acid and $CaCl_2$ on Growth and Yield of Tomato in Arid Environment of Western Rajasthan

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ABSTRACT: A field experiment studied the effect of salicylic acid and calcium chloride ($CaCl_2$) on tomato growth and yield. The experiment used a randomized block design with five salicylic acid sprays (0-200 ppm) and five $CaCl_2$ sprays (0-2%). Results showed that 150 ppm and 200 ppm salicylic acid significantly increased plant height, leaves per plant, and fruit yield. Similarly, 1.5% and 2% $CaCl_2$ sprays also increased these parameters. The highest values were recorded at 200 ppm salicylic acid and 2% $CaCl_2$. The study suggests that salicylic acid and $CaCl_2$ have a positive effect on tomato growth and fruit development, and can be used as a foliar spray to enhance growth, yield, and quality. However, both these treatments significantly increased growth characters at different stage (plant height, number of leaves per plant and DMA/plant, yields attributes (number of fruits per plant, diameter of fruit, average fruit weight, fruit yield per plant and yield during both the year as well as pooled analysis.

Keywords: Tomato, Salicylic acid, $CaCl_2$, DMA, fruit yield, Yield.

INTRODUCTION

Tomato (*Solanum lycopersicum* L.), a member of the Solanaceae family, is a widely cultivated vegetable renowned for its exceptional nutritional value. Rich in proteins, minerals, calcium, and vitamins (particularly vitamin A and C), tomato is considered a protective food. Phenolic compounds produced by plant roots play a crucial role in plant growth and development. Salicylic acid (SA) has been shown to regulate plant growth, development, and responses to environmental stresses (Yalpani *et al*., 1994; Senaratna *et al*., 2000). Low concentrations of SA have been found to enhance photosynthesis, growth, and various physiological and biochemical characteristics in plants (Fariduddin *et al*., 2003). However, high concentrations of SA can induce stress in plants. Pre-treatment with exogenous SA has been reported to increase tomato resistance to cold injury and reduce decay incidence in low-temperature storage (Ding *et al.,* 2002). As an endogenous plant growth regulator, SA has a wide range of metabolic and physiological responses that impact plant growth and development (Hayat *et al*., 2010). Calcium is essential for plant growth, playing a critical role in cell division, elongation, and membrane permeability. Adequate calcium levels are necessary for normal plant membrane function, and calcium pectate formation strengthens cell walls and middle lamellae, improving fruit quality (Carpita and McCann 2000). Calcium also enhances tomato quality by increasing firmness, reducing physiological disorders, delaying ripening, and prolonging shelf life (Sharma *et al*., 1996). Plant hormones regulate Ca transportation and distribution within plants, with auxins promoting Ca transport in tomato fruit (Banuelos *et al*., 1988). The present investigation aimed to study the effect of salicylic acid and $CaCl_2$ on growth, yield attributes, and yield of tomato variety "INDAM- 14301" in the arid environment of western Rajasthan.

MATERIAL AND METHODS

A field experiment was conducted during the winter (*rabi*) seasons of 2020-21 Bikaner, Rajasthan, to study the effect of salicylic acid and $CaCl_2$ on growth and yield of tomato. The experiment was laid out in randomized block design (factorial), comprising combinations of 5 salicylic acid spray and 5 calcium chloride ($CaCl_2$). The soil of experimental site was loamy sand, neutral in reaction, low in available N, medium in available P and medium in available K status. Crop sown on 22 October, 2020-21 and harvested 14 April, 2021. The total rainfall was 255 mm during 2020-21. The maximum and minimum temperature during crop-growing season ranged between 18.3°C to 39.5°C and 2.3°C to 23.8°C and during *rabi* 2020. The treatments comprising combinations of comprising combinations of 5 salicylic acid spray (Fresh Water spray as control, 50 ppm SA spray, 100 ppm SA spray, 150 ppm SA spray, 200 ppm SA spray) and 5 calcium chloride (Fresh Water Spray as control, $CaCl_2$ Spray 0.5%, $CaCl_2$ Spray 1%, $CaCl_2$ Spray 1.5%, $CaCl_2$ Spray 2%). These 25 treatment combinations were replicated thrice. Tomato variety 'INDAM- 14301' was used as a test crop. The seeds were sown in furrow opened at the depth of about 4–5cm using seed rate of 350 g/ha, with inter-row spacing of 0.5m.

RESULTS AND DISCUSSION

The results (Table 1 & 2) indicated that spray of 150 ppm salicylic acid had significant effect on growth characters at different stage (plant height, number of leaves per plant and DMA/plant), yields attributes (number of fruits per plant, diameter of fruit, average fruit weight, fruit yield per plant) and yield which was at par with spray of 200 ppm salicylic acid. However, both these treatments significantly increased growth characters at different stage (plant height, number of leaves per plant and DMA/plant, yields attributes (number of fruits per plant, diameter of fruit, average fruit weight, fruit yield per plant and yield during both the year as well as pooled analysis. Spray of 150 ppm salicylic acid significantly increased plant height at last picking, number of leaves per plant at last picking and DMA/plant, number of fruits per plant, diameter of fruit, average fruit weight, fruit yield per plant and yield during experimental years and pooled analysis. The corresponding increases in plant height at last picking, number of leaves per plant at last picking and DMA/plant, number of fruits per plant, diameter of fruit, average fruit weight, fruit yield per plant and yield with the Spray of 200 ppm salicylic acid was respectively.

The results (Table 1 & 2) indicated that spray of $CaCl_2$ 1.5 % had significant effect on growth characters at different stage (plant height, number of leaves per plant and DMA/plant), yields attributes (number of fruits per plant, diameter of fruit, average fruit weight, fruit yield per plant) and yield which was at par with $CaCl_2$ 2.0 %. However, both these treatments significantly increased growth characters at different stage (plant height, number of leaves per plant and DMA/plant), yields attributes (number of fruits per plant, diameter of fruit, average fruit weight, fruit yield per plant) and yield. Spray of $CaCl_2$ 1.5 % significantly increased plant height at last picking, number of leaves per plant at last picking and DMA/plant, number of fruits per plant, diameter of fruit, average fruit weight, fruit yield per plant and yield during both the years of study and pooled analysis.The corresponding increases in plant height at last picking, number of leaves per plant at last picking and DMA/plant, number of fruits per plant, diameter of fruit, average fruit weight, fruit yield per plant and yield with the $CaCl_2$ 2.0 % was higher. Foliar spraying with salicylic acid (SA) had positive effect on vegetative growth of tomato at the concentrations of 150 and 200 ppm compared with the untreated control. The highest mean values of plant height, number of leaves per plant and DMA/plant, number of fruits per plant, diameter of fruit, average fruit weight, fruit yield per plant and yield were recorded when salicylic acid was sprayed at the concentration of 200 ppm. However, no significant differences were detected between 150 and 200 ppm in terms of plant height, number of leaves per plant and DMA/plant, number of fruits per plant, diameter of fruit, average fruit weight, fruit yield per plant and yield during both the year as well as pooled analysis. The positive effect of salicylic acid on tomato plant growth might be attributed to increased water use, endogenous phytohormones and carboxylation efficiencies in association with high photosynthetic rate in plants. Javaheri, *et al*. (2014); Ilyas *et al*. (2014) also reported that both SA and Ca_2^+ independently increased the plant height of tomato. Application of SA and Ca_2^+ produced higher number of tomato leaves. This result was supported by many authors like Kazemi (2013) and Salem (2013). Previously many authors reported that SA and Ca_2^+ played an important role in the fruit development and setting in many crops. Current result suggest that SA and Ca_2^+ has positive functions on fruit diameter (cm) as supported by the findings of Javaheri *et al*. (2014); Martin *et al*. (2003); Rab and Haq (2012). Significant increase in fruit length with exogenous application of SA and Ca_2^+ was reported by Javaheri *et al*. (2014); Abbasi *et al*. (2013) ; Salem (2013). The exogenous combined application of SA and Ca_2^+ had a great regulatory influence on umber of fruits plant^{-1} and increased the fruit yield as suggested by Javaheri *et al*. (2014); Plasencia *et al*. (2011); Ilyas *et al*. (2014) ; Kazemi (2013). Lolaei (2012); Shehana *et al*. (2001) also reported that application of SA and Ca_2^+ increased the yield of tomato.

Table 1: Effect of salicylic acid and $CaCl_2$ on plant height, No. of leaves at different stages and DMA/ plant (g) of tomato (Pooled data).

Treatments	Plant height (cm)	Number of leaves per plant	DMA/plant (g)
	Last picking	Last picking	
Salicylic acid spray			
S_1	80.76	110.86	141.32
S_2	87.71	119.99	152.26
S_3	92.52	126.49	160.63
S_4	96.80	130.54	168.17
S_5	97.50	133.46	169.42
SEm ±	1.14	1.45	1.84
CD (P = 0.05)	3.19	4.07	5.16
Calcium chloride ($CaCl_2$) spray			
C_1	80.72	111.06	142.28
C_2	88.50	120.91	154.09
C_3	91.33	124.65	159.15
C_4	96.60	131.40	166.31
C_5	98.13	133.33	169.97
SEm ±	1.14	1.45	1.84
CD (P = 0.05)	3.19	4.07	5.16

Table 2: Effect of salicylic acid and $CaCl_2$ on specific gravity, fruit yield per plant and yield ton per hectare of tomato (Pooled data).

Treatments	Number of fruits per plant	Diameter of fruit (cm)	Average fruit weight (g)	Fruit yield per plant (kg)	Yield (t/ha)
Salicylic acid spray					
S_1	13.82	4.05	68.76	1.07	33.68
S_2	14.91	4.39	75.25	1.24	39.63
S_3	15.64	4.70	80.18	1.34	44.74
S_4	16.52	4.96	84.22	1.48	49.11
S_5	16.59	5.02	85.37	1.53	50.16
SEm ±	0.20	0.06	1.01	0.03	1.02
CD (P = 0.05)	0.55	0.18	2.83	0.08	2.86
Calcium chloride ($CaCl_2$) spray					
C_1	13.76	4.08	67.11	1.02	33.53
C_2	14.88	4.46	75.19	1.22	40.30
C_3	15.58	4.71	82.31	1.38	44.84
C_4	16.49	4.89	83.78	1.49	48.82
C_5	16.76	4.99	85.40	1.54	49.82
SEm ±	0.20	0.06	1.01	0.03	1.02
CD (P = 0.05)	0.55	0.18	2.83	0.08	2.86

CONCLUSIONS

It is concluded that spray of salicylic acid @ 150 ppm and $CaCl_2$ @ 1.5 % enhance the growth, yield and quality of tomato. Based on results emanated from the present investigation it is concluded that spray of salicylic acid @ 150 ppm recorded significantly higher fruit yield (49.11 t/ha) and spray of $CaCl_2$ @ 1.5 % gave maximum fruit yield (48.82 t/ha).

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