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Effect of plant growth substances on yield and yield attributing characters in pointed gourd (*Trichosanthes dioica* Roxb.)

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Abstract

This study aimed to reveal the effect of plant growth substances on yield attributes in dioecious pointed gourd (*Trichosanthes dioica* Roxb.) originated in South Asia was carried out during Kharif season of 2023-2024 at College of Horticulture, Venkataramannagudem, W. G. Dist. This experiment was carried out with 13 treatments i.e. silver nitrate (800 ppm AgNO_3 , 850 ppm, 900 ppm, 950 ppm, 1000 ppm and 1050 ppm AgNO_3) and silver thiosulphate (1 mM, 2 mM, 3 mM, 4 mM, 5 mM and 6 mM $\text{Ag}_2\text{S}_2\text{O}_5$) and control. The field was laid out in a Randomized Block Design (RBD) with three replications to know the data on effect of different concentrations of silver nitrate and silver thiosulphate on growth characters and yield contributing characters and yield were recorded and statistically analyzed. During the pre-floral stage, female plants were sprayed with varying amounts of silver nitrate and silver thiosulphate. Application of 950 ppm silver nitrate resulted in higher fruit characteristics such as individual fruit weight, fruit stalk length and fruit diameter followed by 2 mM $\text{Ag}_2\text{S}_2\text{O}_5$ and 900 ppm of AgNO_3 . Compared to the other treatments, the 950 ppm of silver nitrate application produced higher yield components, such as fruit yield and less seed number and showed little amount of parthenocarp. There was also equal stamen and stigma length at 950 ppm concentration of AgNO_3 , which leads to a greater fruit output. The plants sprayed with higher doses of 1050 ppm silver nitrate and 6 mM silver thiosulphate experienced scorching and vine withering indicates the toxicity effect on pointed gourd.

Keywords: Dioecious plant, silver nitrate, silver thiosulphate *Trichosanthes dioica* and yield

Introduction

Pointed Gourd (*Trichosanthes dioica*) is a popular vegetable crop in many parts of Asia, particularly in India, China, and Southeast Asia. It belongs to the Cucurbitaceae family. Long, slender, and cylindrical shape. Green or pale green skin with white or creamy white flesh. Rich in vitamins, minerals, and antioxidants. Used in various culinary dishes, medicinal purposes, and as an ornamental plant. Rich in vitamins A, C and E. Good source of potassium, magnesium, and iron. Low in calories. Sex modification in cucurbits (a plant family that includes cucumbers, melons, squash, and pumpkins) is an important horticultural practice that can significantly impact yield, fruit quality and the efficiency of crop production. Cucurbits produce male and female flowers. In some species, the balance of these flowers can affect fruit production. By manipulating the sex expression (such as increasing the number of female flowers), farmers can improve the number of fruits per plant and leading to uniform and higher yields. Certain sex modification practices can also help in producing fruits with desirable characteristics, improving marketability, consumer satisfaction, managing pests and disease. Manipulating the levels and timing of these growth substances can effectively modify the sex expression in cucurbits, allowing for better control over flowering and fruit production, which is crucial for both commercial agriculture and breeding programs.

In general silver nitrate (AgNO_3) and silver thiosulfate ($\text{Ag}_2\text{S}_2\text{O}_5$) are compounds commonly used in plant biology to induce sex modification, particularly in plants with separate male and female flowers, like cucumbers and squashes. When applied at specific concentrations and stages of plant development, these compounds can influence the sexual expression of the plant.

Silver nitrate (AgNO_3) is known to promote the development of male flowers when applied at low concentrations, while higher concentrations can induce the development of female flowers. This manipulation of flower development can be useful for breeding programs or for controlling fruit production in certain crops. Silver thiosulfate ($\text{Ag}_2\text{S}_2\text{O}_3$), on the other hand, is often used in conjunction with ethylene gas to induce feminization in plants. It works by blocking the action of ethylene, a hormone involved in flower development, leading to the production of more female flowers. Both compounds have been studied extensively for their effects on sex modification in plants and their application techniques continue to be refined for various agricultural purposes, including hybrid seed production and fruit yield optimization.

Exogenous applications of plant growth substances were effective in altering the sex ratio and improving the fruit yield. Sex modification in plants can often be achieved by application of plant growth regulators (Das and Mukherjee, 1986; Marchetti *et al.*, 1992).

Application of silver nitrate and silver thiosulphate

In the earlier study on pointed gourds, female plants with 12-22 leaves (from the tip) received an application of silver nitrate (50-2000 ppm) during the flowering stage (Hoque *et al.*, 2002). As a result, at 800 and 1000 ppm, relatively few hermaphrodite flowers (2-6) were created without viable pollen. As a result, this study modified the application frequency and plant growth stage of the application using six different doses of silver nitrate. The female vines were treated with six concentrations of silver nitrate (800 ppm, 850 ppm, 900 ppm, 950 ppm, 1000 ppm and 1050 ppm AgNO_3) and silver thiosulphate (1 mM, 2 mM, 3 mM, 4 mM, 5 mM and 6 mM $\text{Ag}_2\text{S}_2\text{O}_3$) with control. When the fourth leaf reached a diameter of around 3 cm, the foliar spraying was carried out at the 4-5 leaf (pre-floral) stage of completely expanded stage. In order to make sure the solution went off the shoots properly, it was done manually using a plastic hand sprayer. We used deionized distilled water to make solutions of silver nitrate and silver thiosulphate. Up to the trial's conclusion, the total number of hermaphrodite blooms that appeared on each node was counted.

Observations recorded

The following observations were recorded. Diameter of fruit was measured at the time of picking by cutting with knife at the broadest point and was measured by using scale from tagged fruits per treatment per replication and their average was calculated and expressed in millimeters. Fruit stalk length was measured at the time of picking from tagged fruits per treatment per replication and their mean was expressed in centimeters. Weight of the fruit was measured by using a weighing machine after picking from the tagged fruits per treatment per replication and their mean was calculated and expressed in grams. Days taken for maturity were counted from fruit set to marketable maturity of tagged fruits per treatment per replication and their mean was expressed in days. Fruit yield per vine was calculated by the total weight of marketable fruits obtained from each vine were expressed in kg/vine. Total yield of fruits per hectare based on yield per vine multiplied with total number of productive plants per hectare expressed in kg/ha.

Results and discussion

Fruit diameter (mm)

The effect of silver nitrate and silver thiosulphate at different concentrations on fruit diameter was found to be significant.

Among silver nitrate concentrations, the maximum fruit diameter was obtained with T_4 - 950 ppm AgNO_3 (84.32) followed by T_3 - 900 ppm AgNO_3 (70.53), T_2 - 850 ppm AgNO_3 (68.88) found on par whereas minimum fruit diameter was recorded with T_{13} - control (49.50) and minimum fruit diameter was recorded at the concentration of T_6 - 1050 ppm AgNO_3 (62.07). Among silver thiosulphate concentrations, maximum fruit diameter was obtained with T_8 - 2 mM $\text{Ag}_2\text{S}_2\text{O}_3$ (74.89) followed by T_7 - 1 mM $\text{Ag}_2\text{S}_2\text{O}_3$ (69.45) and T_9 - 3 mM $\text{Ag}_2\text{S}_2\text{O}_3$ (68.51) and minimum fruit diameter was recorded with T_{12} - 6 mM $\text{Ag}_2\text{S}_2\text{O}_3$ (59.12).

Among all concentrations, maximum fruit diameter was obtained with T_4 - 950 ppm AgNO_3 (84.32) followed by T_8 - 2 mM $\text{Ag}_2\text{S}_2\text{O}_3$ (74.89), T_3 - 900 ppm AgNO_3 (70.53) and T_2 - 850 ppm AgNO_3 (68.88) were found on par whereas minimum fruit diameter was recorded with T_{13} - Control (49.50). the results are intune with Stankovic and Prodanovic 2002 ^[7] in cucumber.

Silver nitrate can influence various aspects of fruit development, including fruit diameter. By blocking ethylene action, silver nitrate may promote enhanced cell division and elongation, indirectly affecting fruit size. Ethylene is known to inhibit cell expansion in many plant tissues (Sarkar *et al.* 2015) ^[9]. By applying silver nitrate, the suppression of ethylene allows for continued cell division and elongation. This could result in an increase in fruit diameter in pointed gourd, as the fruit can continue growing for a longer period before ripening and cessation of growth. The impact of silver nitrate on fruit diameter is likely concentration-dependent. Low to moderate concentrations might promote fruit enlargement, while excessively high concentrations could have phytotoxic effects, inhibiting overall plant growth and negatively affecting fruit size.

Fruit stalk length (cm)

Effect of silver nitrate and silver thiosulphate at different concentrations on fruit stalk length was found to be significant.

Among silver nitrate concentrations, maximum fruit stalk length was obtained with T_4 - 950 ppm AgNO_3 (3.35) followed by T_3 - 900 ppm AgNO_3 (2.26), T_2 - 850 ppm AgNO_3 (2.21), and minimum fruit stalk length was recorded at the concentration of T_6 - 1050 ppm AgNO_3 (1.84). Among silver thiosulphate concentrations, fruit stalk length was maximum with T_8 - 2 mM $\text{Ag}_2\text{S}_2\text{O}_3$ (2.82) followed by T_9 - 3 mM $\text{Ag}_2\text{S}_2\text{O}_3$ (2.16) Which was on par with T_5 - 1000 ppm AgNO_3 (2.06), T_{10} - 4 mM $\text{Ag}_2\text{S}_2\text{O}_3$ (1.95), T_1 - 800 ppm AgNO_3 (1.92) and T_{11} - 5 mM $\text{Ag}_2\text{S}_2\text{O}_3$ (1.91), T_{12} - 6 mM $\text{Ag}_2\text{S}_2\text{O}_3$ (1.90), T_6 - 1050 ppm AgNO_3 (1.84) and T_7 - 1 mM $\text{Ag}_2\text{S}_2\text{O}_3$ (1.76) whereas minimum fruit stalk length was recorded with T_{13} - control (1.38). the results are in accordance with the results of Cheng *et al.*, 2002 ^[3] Silver nitrate (AgNO_3) and silver thiosulphate ($\text{Ag}_2\text{S}_2\text{O}_3$) is commonly used in plant studies to modulate hormonal pathways, particularly ethylene signaling. Ethylene is a plant hormone that regulates various physiological processes, including fruit ripening, flowering, and tissue elongation. In the context of pointed gourd (*Trichosanthes dioica* Roxb.), the application of silver nitrate and silver thiosulphate can influence fruit development, including the fruit stalk (pedicel) length (Khan and Panda, 2008) ^[5]. Silver nitrate and silver thiosulphate acts as an ethylene action inhibitor by blocking the ethylene receptor sites in plant tissues. Since ethylene can restrict cell elongation and promote tissue senescence, its inhibition allows for enhanced elongation of the fruit stalk. This could lead to longer pedicels in pointed gourd, making the fruits more accessible for manual harvesting. The inhibition of ethylene through silver nitrate and

silver thiosulphate treatment promotes cell division and elongation in plant tissues, including the pedicel. This can result in increased fruit stalk length by reducing the natural ethylene-induced restriction of growth.

Individual fruit weight (g)

The individual fruit weight showed significant differences among various treatments.

Among silver nitrate concentrations, minimum individual fruit weight was obtained with T₄ - 950 ppm AgNO₃ (28.75) followed by T₃ - 900 ppm AgNO₃ (29.84), T₁ - 800 ppm AgNO₃ (31.45), and maximum individual fruit weight was recorded at the concentration of T₆ - 1050 ppm AgNO₃ (42.29). Among silver thiosulphate concentrations, minimum fruit weight was obtained with T₈ - 2 mM Ag₂S₂O₃ (28.87) followed by T₇ - 1 mM Ag₂S₂O₃ (30.43) and T₁₁ - 4 mM Ag₂S₂O₃ (30.94) and maximum individual fruit weight was recorded with T₁₂ - 6 mM Ag₂S₂O₃ (45.75).

Among all the treatments, minimum individual fruit weight was obtained with T₄ - 950 ppm AgNO₃ (28.75) whereas maximum fruit weight with T₁₃ control (47.17). The less fruit weight in the treatments was due to partial parthenocarp in which few number of seeds noticed. The results are in accordance with Rajput *et al.*, 1994^[6] in Kakrol, Cheng *et al.*, 2002^[3] in summer squash and Hallidri, 2004^[4] in cucumber.

Number of seeds per fruit

The data revealed that the minimum number of seeds per fruit was recorded with T₄ - 950 ppm AgNO₃ application (6.33) followed by 2 mM Ag₂S₂O₃ (7.66) and T₃ - 900 ppm AgNO₃ (8.66). The maximum number of seeds was recorded at T₁₃ - Control (24.00).

Among silver nitrate concentrations, the minimum number of seeds per fruit was recorded with T₄ - 950 ppm AgNO₃ (6.33) followed by T₃ - 900 ppm AgNO₃ (8.66), T₁ - 800 ppm AgNO₃ (10.66), and maximum number of seeds per fruit was recorded at the concentration of T₆ 1050 ppm AgNO₃ (15.33). Among silver thiosulphate concentrations, minimum number of seeds per fruit was obtained with T₈ - 2 mM Ag₂S₂O₃ (7.66) followed by T₇ - 1 mM Ag₂S₂O₃ (11.66) and T₉ - 3 mM Ag₂S₂O₃ (12.66) and maximum number of seeds per fruit was recorded with T₁₃ - control (24.00). Hallidri, 2004^[4] in cucumber found similar findings.

Silver nitrate and Ag₂S₂O₃ influence the seed set and development within the fruits, leading to reduction in the number of seeds. Ethylene plays a significant role in promoting seed development and maturation (Khan and Panda, 2008)^[5]. By inhibiting ethylene through silver nitrate application, the normal process of seed development could be disrupted, leading to a reduction in the number of seeds per fruit. Ethylene is crucial for ovule maturation and seed formation; its suppression might reduce the viability of ovules, thus leading to fewer seeds. Silver nitrate's ethylene inhibition may indirectly affect pollination and fertilization processes. Ethylene is also involved in flower senescence, and its inhibition might delay flower aging, affecting the timing and success of pollination (Singh and Singh, 2015)^[10]. Poor or incomplete pollination could result in reduced seed set in pointed gourd. Silver nitrate delays fruit ripening,

which could interfere with seed maturation. While fruits continue to grow in size, seed development might be compromised due to the extended pre-ripening phase, leading to fewer or smaller seeds. Silver nitrate indirectly affects the balance of other hormones like auxins and gibberellins, which are important for seed and fruit development. While the suppression of ethylene can enhance fruit size, it may also negatively impact seed formation, resulting in fewer seeds per fruit.

Number of days taken for maturity

The data presented in Table 1 revealed that the greater number of days taken for maturity was recorded with T₁₃ - control (8.66) followed by T₇ - 1 mM Ag₂S₂O₃ (8.50) and T₆ - 1050 ppm AgNO₃ (8.16). The minimum number of days taken for maturity was recorded at T₄ - 950 ppm AgNO₃ (4.16).

Among silver nitrate concentrations, less number of days taken for maturity was recorded with T₄ 950 ppm (4.16) followed by T₅ 1000 ppm (6.50), T₃ 900 ppm (6.66) and greater number of days taken for maturity was recorded at the concentration of T₆ - 1050 ppm (8.16). Among silver thiosulphate concentrations, less number of days taken for maturity was obtained with T₈ 1mM Ag₂S₂O₃ (5.50) followed by T₁₂ - 6 mM (6.16) and T₉ - 3 mM (6.33) and greater number of days taken for maturity was recorded with T₇ - 1 mM (8.50).

The control group required more days to reach maturity than the plants treated with silver compounds. Applying silver nitrate and silver thiosulphate resulted in a shorter maturity period compared to control. This technique may not prolong the number of days to maturity. Sanwal *et al.* (2010)^[8] reported comparable results in *Momordica cochinchensis*.

Fruit yield/vine

The data presented in table revealed that maximum fruits per vine was obtained with T₄ - 950 ppm silver nitrate application (8.03) followed by T₈ - 2 mM Ag₂S₂O₃ (7.60) and T₃ - 900 ppm AgNO₃ (6.96) there was no hermaphrodite yield was observed in T₁₃ - Control (0).

Among silver nitrate concentrations, maximum fruits per vine was recorded with T₄ - 950 ppm (8.03) followed by T₃ - 900 ppm (6.96), T₅ - 1000 ppm (6.48) and minimum fruits per vine was recorded at the concentration of T₆ - 1050 ppm₃ (3.94). Among silver thiosulphate concentrations, maximum fruits per vine was obtained with T₈ - 1 mM Ag₂S₂O₃ (7.60) followed by T₉ - 3 mM (6.37) and T₇ - 1 mM (5.65).

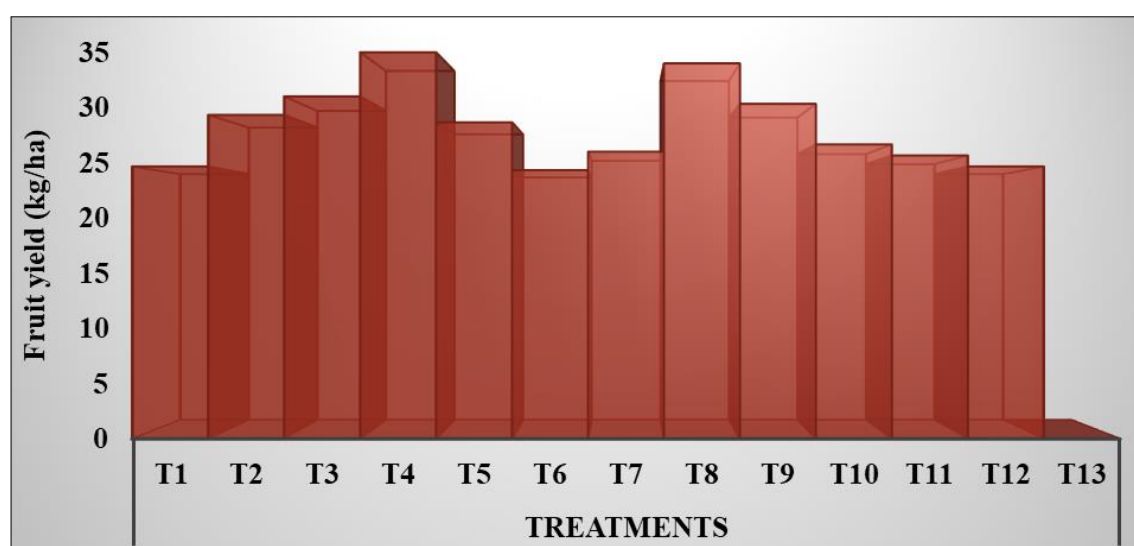
Fruit yield (kg/ha)

The results revealed that maximum fruit yield per ha was obtained with 950 ppm silver nitrate application (35.00) followed by T₈ - 2 mM Ag₂S₂O₃ (34.00) and T₃ - 900 ppm AgNO₃ (31.00). T₈ - 2 mM Ag₂S₂O₃ (34.00) and T₅ - 1000 ppm AgNO₃ (28.66) were found to be on par with the T₆ - 1050 ppm AgNO₃ (24.33). No hermaphrodite yield was obtained with control T₁₃ (0).

A fruit yield of 950 ppm AgNO₃ was the greatest. This could be because, in comparison to other treatments, 950 ppm AgNO₃ produced highest number of hermaphrodite flowers. As

Table 1. Effect of plant growth substances on fruit diameter (mm), fruit stalk length (cm), individual fruit weight (g), number of seeds per fruit, days taken for maturity, fruit yield per vine (kg) and fruit yield (kg/ha) in pointed gourd

Treatments	Fruit diameter (mm)	Fruit stalk length (cm)	Fruit weight (g)	Seeds per fruit	Days taken for maturity	Fruit yield/vine	Fruit yield (kg/ha)
T ₁ - 800 ppm AgNO ₃	60.14	1.92	31.45	10.66	7.00	4.84	24.66
T ₂ - 850 ppm AgNO ₃	68.88	2.21	33.55	11.66	7.50	5.69	29.33
T ₃ - 900 ppm AgNO ₃	70.53	2.26	29.84	8.66	6.66	6.96	31.00
T ₄ - 950 ppm AgNO ₃	84.32	3.35	28.75	6.33	4.16	8.03	35.00
T ₅ - 1000 ppm AgNO ₃	64.67	2.06	31.10	14.33	6.50	6.48	28.66
T ₆ - 1050 ppm AgNO ₃	62.07	1.84	42.29	15.33	8.16	3.94	24.33
T ₇ - 1 mM Ag ₂ S ₂ O ₃	69.45	1.76	30.43	11.66	8.50	5.65	26.00
T ₈ - 2 mM Ag ₂ S ₂ O ₃	74.89	2.82	28.87	7.66	5.50	7.60	34.00
T ₉ - 3 mM Ag ₂ S ₂ O ₃	68.51	2.16	32.70	12.66	6.33	6.37	30.33
T ₁₀ - 4 mM Ag ₂ S ₂ O ₃	63.34	1.95	31.80	14.33	7.16	5.49	26.66
T ₁₁ - 5 mM Ag ₂ S ₂ O ₃	62.09	1.91	30.94	14.66	7.33	4.91	25.66
T ₁₂ - 6 mM Ag ₂ S ₂ O ₃	59.12	1.90	45.75	15.66	6.16	3.86	24.66
T ₁₃ - Control	49.50	1.38	47.17	24.00	8.66	0	0
SE(m)±	0.05	0.07	0.27	0.44	0.40	0.212	0.39
CD at 0.05%	0.14	0.22	0.79	1.29	1.18	0.623	1.16

**Fig 1:** Effect of plant growth substances on fruit yield (kg/ha) in pointed gourd

The maximum blooms are transformed into hermaphrodite flowers, the best yield was reported with 950 ppm AgNO₃. When treated with 950 ppm AgNO₃, the proportion of induced hermaphrodite blooms on female plants was highest, and on 1050 ppm AgNO₃, it was lowest. The results of the present experiment are in agreement with the observations made by Beyer (1976) ^[2], Atsmon and Tabbak (1979) ^[1], Takahashi and Jaffe (1984). Similar findings were also observed in *Cucumis sativa* by (Stankovic and Prodanovic 2002) ^[7] and in *Kakrol (M. dioica)* by Rajput *et al.* (1994) ^[6].

Since the plant is primarily dioecious, we may expect the appearance of a few hermaphrodite flowers per vine with appropriate concentration, though the number could vary widely. The application must be timed with early stages of vine development for the best effect. Factors like environmental conditions and vine health will significantly affect the success rate. Generally, we might see a 60-80% success rate in flower induction with proper application. Inducing hermaphrodite flowers in pointed gourd may lead to an increase in fruit production by promoting better pollination and increasing the number of fruit-bearing flowers. However, the actual yield increase will depend on factors like plant response, environmental conditions, and the efficiency of the treatment method used.

Conclusion

In conclusion, the application of plant growth substances significantly enhances the yield and quality of pointed gourd. By influencing key physiological processes, such as flowering, fruit development. Maximum fruit diameter, fruit stalk length, individual fruit weight, number of seeds per fruit, and fruit yield were achieved by pre-flowering treatment of silver nitrate at 950 ppm concentration. This was followed by 2 mM Ag₂S₂O₃ and 900 ppm of AgNO₃. Higher concentrations increased symptoms such as burning and wilting. The strategic use of these hormones can lead to more efficient cultivation practices and greater profitability for farmers. Future research and practical implementation will be essential to optimize their use in pointed gourd production and ensure sustainable agricultural practices.

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