Original Research Article

FOLIAR APPLICATION OF SALICYLIC ACID AND ZINC SULPHATE LEVELS ON GROWTH AND YIELD OF SQUASH UNDER NET HOUSE CONDITION

Abstract

A field experiment was conducted at Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka during November, 2020 to February, 2021. The experiment was laid out in a Randomized Complete Block Design with three replications. The experiment had two factors (Different levels of salicylic acid, S_0= No salicylic acid (control), S_1= 60 ppm of salicylic acid, S_2= 90 ppm of salicylic acid and different levels of zinc, Z_0= No zinc sulphate (control), Z_1= 25 ppm of zinc sulphate, Z_2= 50 ppm of zinc sulphate. Different levels of salicylic, zinc sulphate and also their combinations showed significant influence on different growth, yield contributing parameters and yield of squash. The treatment, S_2 showed highest results in fruit yield per plant (2422.7 g), fruit yield per plot (9.68 kg) and fruit yield per ha (37.83 t) compared to control. In case of zinc treatments, the highest results in fruit yield per plant (2597.1 g), highest fruit yield per plot (10.38 kg) and highest fruit yield per ha (31.74 t) were found from Z_1 compared to control. Likewise, the treatment combination of S_2Z_1 (90 ppm of salicylic acid and 25 ppm of zinc sulphate) gave the highest fruit yield per plant (3045.4 g) fruit yield per plot (12.18 kg) and highest yield per ha (47.57 t) where the lowest results were found from the treatment combination of S_0Z_0 (control). The highest gross return (BDT 1189425), net return (BDT 881669) and BCR (3.86) were obtained from the treatment combination of S_2Z_1 where the lowest was obtained from S_0Z_0. It can be concluded that from economic point of view, S_2Z_1 (90 ppm of salicylic acid and 25 ppm of zinc sulphate) treatment combination is suitable for squash cultivation than other treatment combinations.

Key Words: Salicylic Acid, Zinc Sulphate, squash cultivation, morphological growth,

1. INTRODUCTION

"Squash (*Cucurbita pepo* L) is one of the most important vegetable crops that belong to the *Cucurbitaceae* family. It is one of the largest families in the plant kingdom which consists of largest number of edible plant species. This family also consists of about 30 species of annual, tendril-bearing plants of the family Cucurbitaceae" [1]. "Four species which are commonly cultivated: *Cucurbita maxima*, *Cucurbita mixta*, *Cucurbita moschata,* and *Cucurbita pepo.* Squash is one of the most versatile and delicious foods available all over the world, which packs a serious punch in health and medicinal benefits. It is rich in nutrients and bioactive compounds contents such as phenolics, flavonoids, vitamins (including β-carotene, vitamin A, vitamin B2, Vitamin B6, α- tocopherol, vitamin C, and vitamin E), lutein, zeaxanthin, protein, amino acids, carbohydrates and minerals (especially potassium), magnesium, potassium. And it is low in energy content (about 17 K cal/100 g of fresh pumpkin) and has large amount of fiber" [2]. "That why, In Bangladesh, this relatively new crop is increasingly gaining high levels of economic importance both in generation of income and provision of nutritional value. Squash is cultivated in our country during the winter season when rainfall is scanty and for its growth and development optimum temperature requirement is within 18-28^{o}C. Most of the time irrigation and weed management increases the total cost of production of crops and ultimately growers can be frustrated" [20,21]. "To increase the production of this vegetable some management practices can be followed. Foliar spray of different micronutrients and plant growth regulators can play a great role in these practices. Zinc sulphate ($ZnSO_4$) is one of the first micronutrients that is recognized as essential for plants and taken up by the plant in ionic form (Zn^{2+}). Zinc is a cofactor of over 300 enzymes and also the constituent of many proteins that are involved in cell division, nucleic acid metabolism and protein synthesis. Zinc is essential for the synthesis of tryptophan, a precursor of IAA which is essential for normal cell division and other metabolic processes and helps in the formation of chlorophyll. Plant growth regulators are now widely used as a magic substance in modem farming. Plant hormone influence the growth and development of the plant including plant cell division, enlargement and differentiation, photosynthesis, flowering and fruiting of plant. Salicylic acid is phenolic Phyto hormones which found in plants, have roles in plant morphology and development, photosynthesis, transpiration, ion uptake and transport. Salicylic acid is also involved in endogenous signaling, mediating in plant defense against pathogens. It plays an important role in the resistance to pathogens by inducing the production of pathogenesis-related proteins" [3]. Therefore, salicylic acid improved morphological growth, development and yield of squash. However, very limited research

was conducted to improve the growth and yield of squash by foliar application of salicylic acid and zinc sulphate. Hence, the study was under taken to find out the effect of different levels of salicylic acid, influence of foliar spraying of different levels of zinc sulphate and suitable combination of salicylic acid and zinc sulphate on growth and yield of squash.

2. MATERIALS AND METHODS

2.1 Experimental Site and Experimental Framework

The experiment was conducted during the period from 10 October 2020 to February 2021 at the "Horticulture Farm" of Sher-e-Bangla Agricultural University, Dhaka-1207. The experimental site was located at 23°74′ N latitude and 90°35′ E longitudes at an altitude of 8.2 m. The experiment consisted of two factors as mentioned below: **Factor A:** Salicylic acid (Levels) *viz*., S_0 = No Salicylic acid (control), S1 = 60 ppm Salicylic acid, S_2 = 90ppm Salicylic acid. **Factor B:** Zinc sulphate (Levels) *viz*., Z_0 = No Zinc (control), Z_1 = 25 ppm Zinc sulphate, Z_2 = 50 ppm Zinc sulphate. The experiment was laid out in a Randomized Complete Block Design (RCBD) with 3 replications. The size of unit plot was 1.5 m × 1.5 m. The total number of treatments was nine and the number of plots was 27.

2.2 Planting materials

The vegetable crop; squash was considered for the present study. Seeds of Squash F_1 hybrid variety was used

2.3 Manures and fertilizers application

Total 15 ton/ha cow dung, 170 Kg ha^{-1} urea, 170 Kg ha^{-1} triple super phosphate, 150 Kg ha^{-1} muriate of potash were applied in the field. Full amount of triple super phosphate, muriate of potash and well rotten cow dung were applied at the time of final land. Urea was applied in two equal installments at 25 and 35 days after transplanting (DAT) respectively

2.4 Sowing of seed

Seeds were sown in the poly bags on 22 November, 2020. Each poly bag contained two seeds of squash. After sowing, the seeds were covered with light soil after sowing watering was done by water cane regularly. Complete germination of the seeds took place with 5 days after seed sowing. No chemical fertilizer was used in the poly bags which was used for sowing seed

2.5 Transplanting of seedlings

Healthy and uniform sized 16 days old seedlings were taken separately from the seedbed and were transplanted in the experimental field on 15 December, 2020. Plant spacing 40 cm × 40 cm was maintained for transplanting. The seedbed was watered properly before uprooting the seedlings so as to minimize the damage of the roots of young seedlings. This operation was carried out during late hours in the evening to minimize the shock of transplanting.

2.6 Statistical Analysis

"The collected data were compiled and tabulated. Statistical analysis was done on various plant characters to find out the significance of variance resulting from the experimental treatments. Data were analyzed using analysis of variance (ANOVA) technique with the help of computer package program Statistics 10 (software) and the mean differences were adjudged by least significant difference test (LSD) as laid out by" [4].

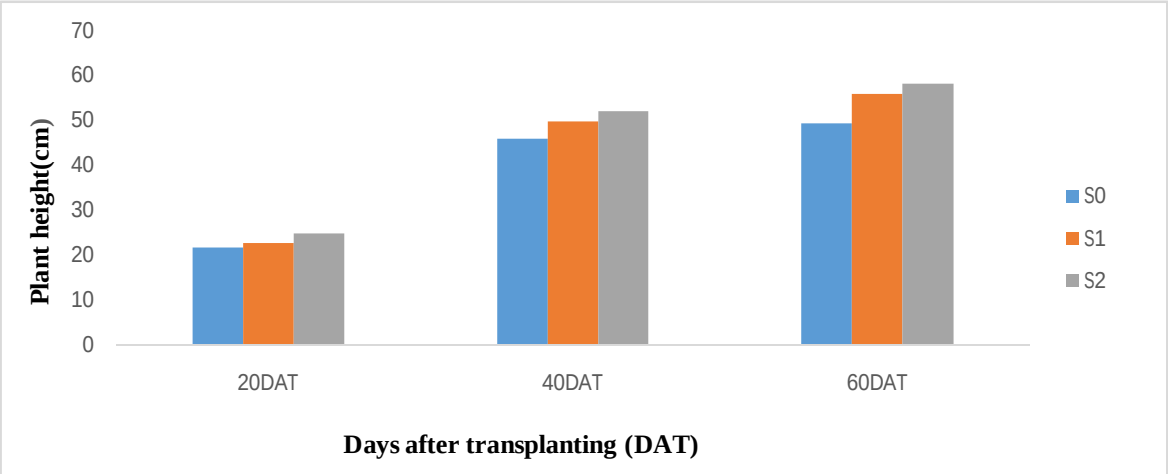
3. RESULTS AND DISCUSSION

3.1 Plant height

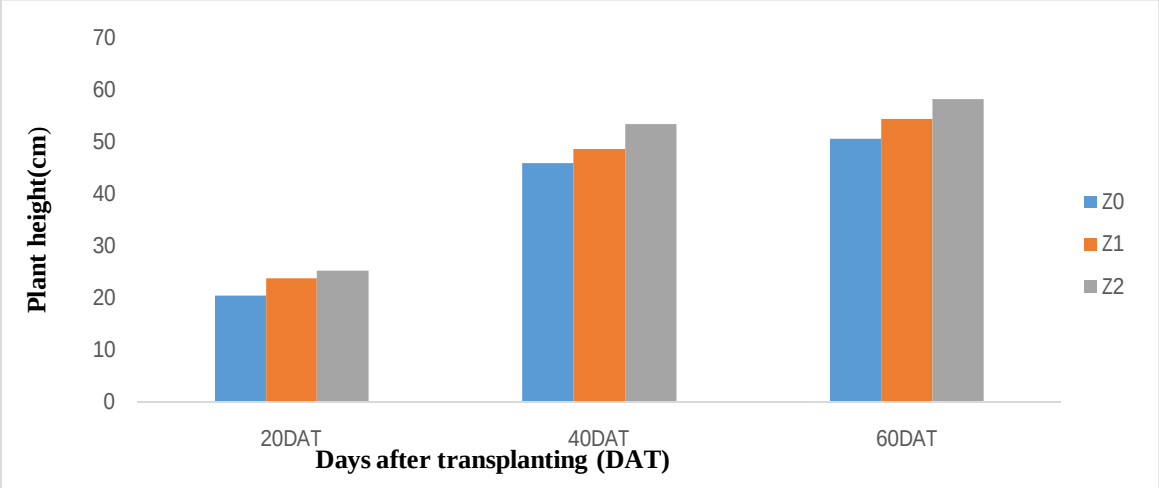
Plant height is an important growth characteristic of a plant, which may closely relate to proper growth and development. Plant height of squash was significantly varied due to the application of different concentrations of salicylic acid at 20, 40 and 60 DAT (Fig 1). At 60 DAT, the highest plant height (58.20 cm) was found from the treatment S_2 (90 ppm of salicylic acid) where the lowest plant height (49.43cm) was found from the control treatment S_0 (control). [5] concluded that salicylic acid applicationhelp to increase cell division and cell enlargement. Increased cell division and enlargement of cell ultimately help to increase plant height.

Application of zinc sulphate also showed significantly positive influences on the plant height at 20, 40 and 60 DAT (Fig 2). Further, at 60 DAT, the highest plant height (58.34 cm) was measured from Z_2 (50 ppm of zinc sulphate) treatment and the lowest plant height (50.69 cm) was recorded from Z_0 (control) treatment. [6] And [7] also showed in their study "the same result that foliar application of

zinc increases the plant height. The fact is that, the application of zinc sulphate helps to enhance vegetative growth in plant".



Here, S_0 = No salicylic acid (control), S_1 = 60 ppm of salicylic acid, S_2 = 90 ppm of salicylic
Fig.1. Effect of salicylic acid on plant height at different days after transplanting (DAT) of squash



Here, Z_0 = No zinc sulphate (control), Z_1 =25 ppm of zinc sulphate, Z_2 = 50 ppm of zinc sulphate
Fig. 2. Effect of different levels of zinc sulphate on plant height at different DAT of squash.

However, combined effects of salicylic acid and zinc sulphate had a significant influence on plant height at 20-60DAT (Table1). At 60 DAT, the tallest plant height (63.75 cm) was obtained from Z_2S_2 (90 ppm of salicylic acid and 50 ppm of zinc sulphate) treatment combination which was statistically similar to S_1Z_2 treatment combination and the shortest plant height (46.20 cm) was found from Z_0S_0 (control) treatment combination which was statistically similar to S_0Z_1 and S_0Z_2 treatment combination.
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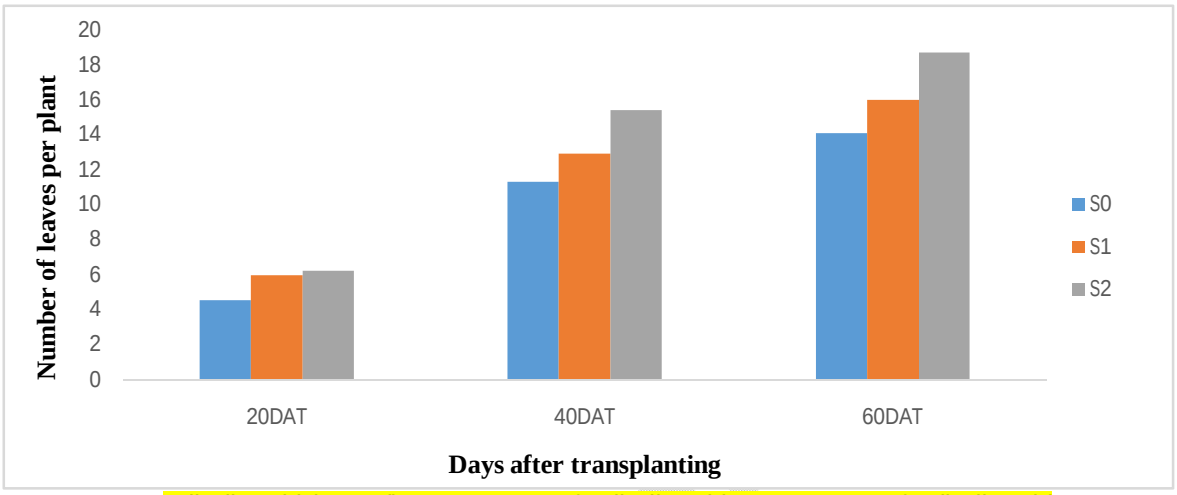
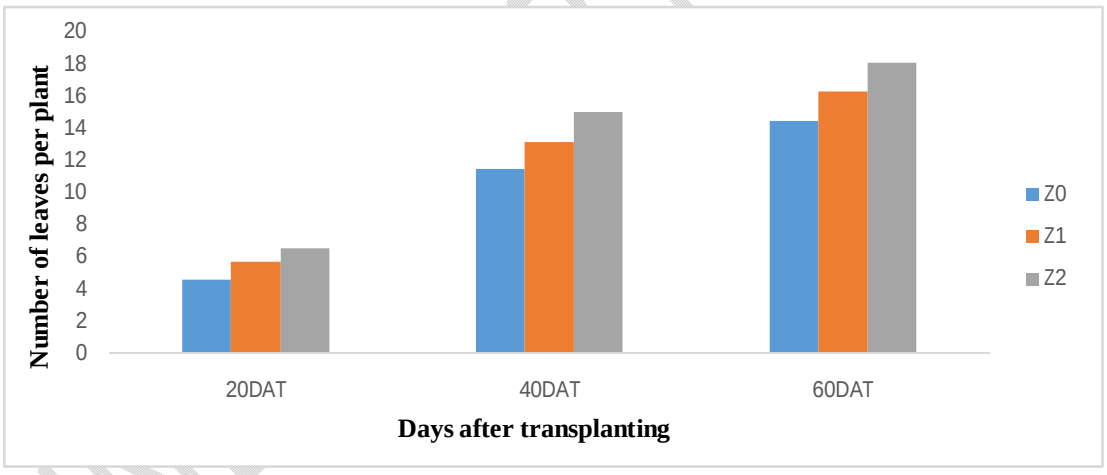
3.2 Number of leaves per plant

Number of leaves per plant is a vital part of crop plant because the primary function of a leaf is to keep the plant alive by producing food for plant through the photosynthesis process. These numbers of leaves per plant was significantly affected by different levels of salicylic acid treatment at 20 DAT to 60 DAT (Fig 3). At 60 DAT, maximum number of leaves per plant (18.70) was obtained from S_2 (90ppm of salicylic acid) treatment and minimum of number of leaves per plant (11.63) from the S_0 (control) treatment. Similar result was obtained by [8] and [9] in their experiment. Which, means that the foliar application of salicylic acid increases the leaf number of plants.

Different levels of zinc sulphate treatments also significantly influence the number of leaves per plant at 20, 40 and 60 DAT in squash plant (Fig 4). At 60 DAT maximum number of leaves per plant (18.08) was recorded in treatment Z_2 (50 ppm of zinc sulphate) and minimum number of leaves per plant (14.47) was observed in Z_0 (control) treatment. [10] results also support the findings from this research outcomes. [11] reported that zinc and manganese have long been considered as essential micronutrients to plant growth which have positive effect on plant leaves number.



Here, S_0 = No salicylic acid (control), S_1 = 60 ppm of salicylic acid, S_2 = 90 ppm of salicylic acid
Fig.3. Effect of different levels of salicylic acid on number of leaves at different DAT of squash.



Here, Z_0 = No zinc sulphate (control), Z_1 =25 ppm of zinc sulphate, Z_2 = 50 ppm of zinc sulphate
Fig.4. Effect of zinc sulphate on number of leaves at different days after transplanting (DAT) of squash

The variation of number of leaves per plant was also observed at 20, 40 and 60 DAT due to the combined application of different level of salicylic acid and zinc sulphate on squash plant (Table 1). At 60 DAT, maximum number of leaves (21.11) was observed in treatment combination Z_2S_2 (90 ppm of salicylic acid and 50 ppm of zinc sulphate) which was statistically similar with S_2Z_1 (90 ppm of salicylic acid and 25 ppm of zinc sulphate) treatment combination and minimum in control (Z_0S_0) (3.47, 9.44 and 11.63) was found at 20, 40 and60 DAT.

Table 1. Combined effect of different levels of salicylic acid and zinc sulphate on plant height and number of leaves per plant at different DAT of squash.

Treatment Combinations	Plant height (cm)			Number of leaves per plant		
	20DAT	40DAT	60DAT	20DAT	40DAT	60DAT
S_0Z_0	19.26 e	42.36 f	46.20 e	3.57 e	9.44 e	11.63 d

S_0Z_1	22.28 bcde	45.34 ef	50.38 de	4.23 de	11.81cd	14.71 c
S_0Z_2	23.74 abcd	50.26 bcd	51.71 cde	5.80 abcd	12.61 bcd	15.93 bc
S_1Z_0	20.34 de	46.76 de	52.26 cd	4.94 cde	11.27 de	14.95 c
S_1Z_1	23.08 bcd	49.23 cde	55.83 bcd	6.16 abc	12.81 bcd	15.88 bc
S_1Z_2	24.83 abc	53.81 ab	59.57 ab	6.77 ab	14.66 b	17.22 bc
S_2Z_0	21.95 cde	48.76 cde	53.63 cd	5.10 bcde	13.72 bc	16.76 bc
S_2Z_1	25.76 ab	51.28 bc	57.23 bc	6.55 abc	14.81 b	18.23 ab
S_2Z_2	27.12 a	56.46 a	63.75 a	7.05 a	17.72 a	21.11 a
CV%	9.18	5.12	5.96	11.88	10.17	10.82
$LSD_{(0.05)}$	2.67	2.06	1.61	1.76	2.32	3.05

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.

Here, S_0 = No salicylic acid (control), S_1 = 60 ppm of salicylic acid, S_2 = 90 ppm of salicylic acid. Z_0 = No zinc sulphate (control), Z_1 =25 ppm of zinc sulphate, Z_2 = 50 ppm of zinc sulphate.

3.3 Days to 1st male flowering

Days to 1st male flowering of squash varied significantly in terms of different salicylic acid levels (Table 2). The lowest (11.22) days to 1st male flowering was found from S_2 (90 ppm of salicylic acid) treatment whereas the highest (12.91) days to 1st male flowering was recorded from S_0 (control) treatment.

Statistically significant variation was recorded in terms of days to 1st male flower initiation due to application of different levels Zinc sulphate (Table 2). The lowest (9.74) days to 1st male flowering was found from Z_1 (50ppm of zinc sulphate) treatment and highest (14.82) days to transplanting to 1st male flowering was found from Zo (control) treatment.

There had significant variation found among the treatment combination of different levels of salicylic acid and zinc sulphate in terms of days to 1st male flowering of squash (Table 3). The highest (16.76) days to 1st male flowering was observed from S_0Z_0 (control) treatment combination which is statistically similar to S_1Z_0 treatment combination and the lowest (9.28) days to 1st male flowering was recorded from S_2Z_1 (90 ppm salicylic acid and 25 ppm zinc sulphate) treatment combination which is statistically similar to S_2Z_2, S_1Z_1 and S_0Z_1 treatment combinations.

3.4 Days to 1st female flowering

Application of different levels of salicylic acid showed variation in days to 1st female flowering (Table 2). The highest days to 1st female flowering (16.17) was recorded from S_0 (control) treatment and the lowest days to 1st female flowering (14.22) was recorded from S_2 (90ppm salicylic acid) treatment. The result of the experiment was in coincided with the findings of

In terms of days to 1st female flowering in relation with different levels of zinc sulphate displayed a statistically significant difference under the present trial (table 2). The maximum Days to 1st female flowering (18.79) was recorded from Z_0 (control) treatment and the minimum days to 1st female flowering (11.80) was recorded from Z_1 (25 ppm of zinc sulphate) treatment. The results indicated that minimum days were required for transplanting to 1st female flower by the Z_1 treatment among the different levels of zinc sulphate treatment. From the results it is evident that zinc sulphate had significant influence on the time to first female flower. Similar result was found in pointed gourd by [12].

It was observed that the combined effect of different levels of salicylic acid and zinc sulphate on days to 1st female flowering was statistically significant (Table 3). The highest number of days to 1st female flowering (20.13) was recorded from the treatment combination S_0Z_0 (control) which was statistically similar to S_1Z_0 and the lowest days to 1st female flowering (11.31) was recorded from the treatment combination of S_2Z_1 (90 ppm salicylic acid and 25 ppm zinc) which was similar to S_1Z_1, S_1Z_1 treatment combination which is consider as control in this study.

Table 2. Effect of different levels of salicylic acid and zinc sulphate on days of 1st male and female flowering, number of male and female flowers per plant of squash.

Treatment	Days of 1st male flower	Days of 1st female flower	Number of male flowers per plant	Number of female flowers per plant
Effect of Salicylic acid				
S_0	13.91 a	16.97 a	6.53 c	9.23 c
S_1	12.26 b	15.02 b	8.30 b	11.86 b

S_2	11.22 c	14.23 c	9.22 a	13.36 a
LSD value (0.05)	0.58	1.26	1.21	1.42
Effect of Zinc sulphate				
Z_0	14.82 a	18.79 a	6.22 c	9.18 c
Z_1	9.74 c	11.81 c	9.87 a	13.53 a
Z_2	11.83 b	14.83 b	7.97 b	11.74 b
LSD value (0.05)	1.23	1.26	1.21	1.42

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.
Here, S_0 = No salicylic acid (control), S_1 = 60 ppm of salicylic acid, S_2 = 90 ppm of salicylic acid. Z_0 = No zinc sulphate (control), Z_1 =25 ppm of zinc sulphate, Z_2 = 50 ppm of zinc sulphate.

3.5 Number of male flowers per plant

A significant difference was obtained on number of male flowers per plant due to the effect of salicylic acid (Table 2) The highest number of male flowers (9.22) per plant was recorded in S_2 (90 ppm of salicylic acid) treatment and the lowest number of male flowers (6.53) per plant was recorded from S_0 (control) treatment. The results indicated that maximum male flowers in number were produced by the application of 90 ppm salicylic acid compared with the control.
Application of zinc sulphate showed variation on number of male flowers per plant of squash at different days after transplanting (DAT) (Table 2). Number of male flowers per plant ranged from 6.22 to 9.86. The highest number of male flowers (9.86) per plant was recorded in Z_1 (25 ppm of zinc sulphate) and the lowest number of male flowers (6.22) per plant in Z_0 (control). The fact is that, adequate supply of zinc sulphate helped to get reproduction and development of squash plant. The present finding is agreed with the finding of [13], [14].
Positive variation was observed in number of male flowers per plant due to combine effect of different levels of salicylic acid and zinc sulphate (Table 3). The highest number of male flowers (11.51) per plant was found in S_2Z_1 (90 ppm of salicylic acid and 25 ppm of zinc sulphate) treatment combination which was statistically similar to S_1Z_1 treatment combination. While the lowest number of male flowers (5.62) per plant was recorded in S_0Z_0 (control) treatment combination which was statistically similar to S_0Z_2, S_1Z_0 and S_2Z_0 treatment combinations.

3.6 Number of female flowers per plant

A significant variation was found due to the effect of salicylic acid on number of female flowers per plant (Table 2). The highest number of female flowers (13.36) per plant was recorded in S_2 (90ppm of salicylic acid) treatment and the lowest number of female flowers (9.23) per plant was recorded from S_0 (control) treatment. The results indicated that maximum female flowers in number were produced by the application of 90 ppm salicylic acid compared with the control.
Number of female flowers per plant was significantly influenced by zinc sulphate application in squash plant (Table 2). The highest number of female flowers (13.53) was recorded in Z_1 (25 ppm of zinc sulphate) treatment. The lowest values in number of female flowers (9.18) per plant were found in Z_0 (control) treatment. The fact that, adequate supply of zinc sulphate helps to get reproductive development of squash plant. The present finding is agreed with the finding of [15], [14] and [16].
Positive variation in number of female flowers per plant was recorded due to combined effect of different levels of salicylic acid and zinc sulphate application (Table 3). The highest number of female flowers (15.29) per plant was found in S_2Z_1 (90 ppm of salicylic acid and 25 ppm of zinc sulphate) treatment combination which was similar to S_2Z_2 and S_1Z_1 treatment combinations. The lowest number of female flowers (7.44) per plant was observed in S_0Z_0 (control) treatment combination which is similar to S_0Z_2 and S_1Z_0 treatment combinations.

Table 3. Combined effect of different levels of salicylic acid and zinc sulphate on days of 1st male and female flowering, number of male and female flowers per plant of squash.

Treatment combinations	Days of 1st male flower	Days of 1st female flower	Number of male flowers per plant	Number of female flowers per plant
S_0Z_0	16.76 a	20.13 a	5.62 f	7.44 f
S_0Z_1	10.06 de	12.18 fg	7.97 cde	11.45 cd
S_0Z_2	11.93 cd	16.20 cd	6.01 ef	8.82 ef

S_1Z_0	14.70 ab	18.59 ab	6.27 ef	9.65 def
S_1Z_1	9.88 de	11.93 fg	10.12 ab	13.86 abc
S_1Z_2	12.21c	14.56 de	8.52 bcd	12.07 bcd
S_2Z_0	13.02 bc	17.65 bc	6.77 def	10.46 de
S_2Z_1	9.28 e	11.31 g	11.51 a	15.29 a
S_2Z_2	11.36 cde	13.72 ef	9.38 bc	14.34 ab
CV%	10.13	8.33	15.15	12.27
$LSD_{(0.05)}$	2.13	2.18	2.10	2.45

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.
Here, S_0 = No salicylic acid (control), S_1 = 60 ppm of salicylic acid, S_2 = 90 ppm of salicylic acid. Z_0 = No zinc sulphate (control), Z_1 =25 ppm of zinc sulphate, Z_2 = 50 ppm of zinc sulphate.

3.7 Number of fruits per plant

Number of fruits per plant was showed statistically significant variation for the application of salicylic acid (Table 4). The highest number of fruits (11.93) per plant was observed in S_2 (90 ppm of salicylic acid) treatment and the lowest number of fruits (6.78) was recorded from S_0 (control). That means application of 90 ppm salicylic acid help to increase fruits number per plant.
Application of zinc sulphate showed positive influences on total number of fruits per plant of squash (Table 4). The total number of fruits per plant ranged from 8.14-11.31. The highest value of total number of fruits (11.31) per plant was recorded for Z_1 (25 ppm of zinc sulphate) treatment and lowest number of fruits (8.14) per plant for Z_0 (control). The fact that, adequate supply of zinc helped to get reproductive development of squash. The present finding is agreed with the finding of [13] and [14] they observed Zn has appositive effect on cucumber fruit production.
Statistically significant variation was observed due to interaction of salicylic acid and zinc sulphate on fruits per plant of squash at different concentrations (Table 5). The highest number of fruits (13.37) per plant was observed from S_2Z_1 (90 ppm of salicylic acid and 25 ppm of zinc sulphate) treatment combination which was similar to S_2Z_2 and S_1Z_1 treatment combinations. While the lowest number of fruits (5.44) per plant was recorded in S_0Z_0 (control) treatment combination which was statistically similar to S_0Z_1 and S_0Z_2 treatment combinations.

3.8 Fruit yield per plant

Statistically significant variation was recorded in yield per plant of squash for the application of different levels of salicylic acid (Table 4) The maximum fruit yield per plant (2422.7 g) was found in S_2 (90ppm of salicylic acid) treatment and the minimum fruit yield per plant (1505.1 g) was obtained from S_0 (control) treatment. At 90 ppm concentration salicylic acid helps to increase the yield of squash plant by mitigating different stress.
Significant influence was found due to application of zinc sulphate on fruit yield per plant (Table 4). The fruit yield per plant widely ranged from1466.5 to 2597.1 g. The highest fruit yield per plant (2597.1 g) was recorded in Z_1 (25 ppm of zinc sulphate) treatment and the lowest fruit yield per plant (1466.5 g) was found in Z_0 (control). The fact that, adequate supply of zinc sulphate helped to get reproductive development of squash.
Combined effect of salicylic acid and zinc sulphate showed significant differences on fruit yield per plant of squash (Table 5). The treatment combination S_2Z_1 (90 ppm of salicylic acid and 25 ppm zinc sulphate) gave the maximum fruit yield per plant (3045.4g) which was similar to S_1Z_1 (60 ppm of salicylic acid and 25 ppm zinc sulphate) treatment combination whereas the minimum fruit yield per plant (1157.6 g) was observed in S_0Z_0 (control) treatment combination which was statistically similar to S_0Z_2 treatment combination.

Table: 4. Effect of different levels of salicylic acid and zinc sulphate on number of fruits per plant, fruit yield per plant (g), fruit yield per plot (kg) and fruit yield ha (t) of squash

Treatment	Number of fruits per plant	Fruit yield per plant (g)	Fruit yield per plot (Kg)	Fruit yield per ha (t)
Effect of Salicylic acid				
S_0	6.78 c	1505.1 c	6.02 c	23.51 c
S_1	10.31 b	2168.6 b	8.67 b	33.88 b

S_2	11.94 a	2422.7 a	9.68 a	37.83 a
LSD value (0.05)	1.56	200.16	0.79	3.120
Effect of Zinc sulphate				
Z_0	8.14 b	1466.5 c	5.86 c	22.91 c
Z_1	11.32a	2597.1 a	10.38 a	40.57 a
Z_2	9.56 b	2032.8 b	8.13 b	31.74 b
LSD value (0.05)	1.56	200.16	0.79	3.12

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.
Here, S_0 = No salicylic acid (control), S_1 = 60 ppm of salicylic acid, S_2 = 90 ppm of salicylic acid. Z_0 = No zinc sulphate (control), Z_1 =25 ppm of zinc sulphate, Z_2 = 50 ppm of zinc sulphate.

3.9 Fruit yield per plot

Application of salicylic acid exhibited a significant influence on the fruit yield per plot of squash plant (Table 4). The highest fruit yield per plot (9.68 kg) was found from the S_2 (90ppm of salicylic acid) treatment and the lowest fruit yield per plot (6.02 kg) from the S_0 (control) treatment. [19] and [17] reported that increasing all the vegetative characteristics salicylic acid increase the yield of the plant.
Significant variation was found among the fruit yield per plot of squash due to the application of different levels of zinc sulphate treatment in squash plant (Table 4). The highest fruit yield per plot (10.38 kg) was obtained from the Z_2 (25ppm of zinc sulphate) treatment and the lowest fruit yield per plot (5.86 kg) from the Z_0 (control) treatment.

Table 5. Combined effect of different levels of salicylic acid and zinc sulphate on number of fruits per plant, fruit yield per plant, fruit yield per plot and fruit yield ha of squash

Treatment combinations	Number of fruits per plant	Fruit yield per plant (g)	Fruit yield per plot (Kg)	Fruit yield per ha (t)
S_0Z_0	5.44 g	1157.6 g	4.63 g	18.09 g
S_0Z_1	7.86 efg	1963.5 de	7.85 de	30.66 de
S_0Z_2	7.05 fg	1394.3 fg	5.57 fg	21.78 fg
S_1Z_0	8.38 def	1510.9 f	6.04 f	23.60 f
S_1Z_1	12.71 ab	2782.5 ab	11.13 ab	43.47 ab
S_1Z_2	9.83 cde	2212.4 cd	8.85 cd	34.56 cd
S_2Z_0	10.62 bcd	1731.0 ef	6.92 ef	27.03 ef
S_2Z_1	13.37 a	3045.4 a	12.18 a	47.57 a
S_2Z_2	11.81 abc	2491.6 bc	9.96 bc	38.90 bc
CV%	16.17	9.86	9.84	9.84
$LSD_{(0.05)}$	2.71	346.68	1.38	1.47

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter (s) differ significantly as per 0.05 level of probability.
Here, S_0 = No salicylic acid (control), S_1 = 60 ppm of salicylic acid, S_2 = 90 ppm of salicylic acid. Z_0 = No zinc sulphate (control), Z_1 =25 ppm of zinc sulphate, Z_2 = 50 ppm of zinc sulphate.

Combined application of different levels of salicylic acid and zinc sulphate significantly increased the fruit yield of squash in per plot ((Table 5). The highest fruit yield per plant (12.18 kg) was obtained from the S_1Z_2 (90 ppm of salicylic acid and 25 ppm of zinc sulphate) treatment combination which is statistically similar to S_1Z_1 (60ppm salicylic acid and 25 ppm of zinc sulphate treatment combination and the lowest fruit yield per plot (4.63 kg) was obtained from the Z_0S_0 (control) treatment combination which was statistically similar to S_0Z_2 treatment combination.

3.10 Fruit yield per ha

Application of salicylic acid also exhibited a significant influence on the fruit yield per hectare ((Table 4). The highest fruit yield per hectare (37.83 t) was found from the treatment S_2 (90ppm of salicylic acid) and the lowest fruit yield per hectare (23.5 t) from the S_0 (control) treatment. These results are in agreement with that obtained by [18] and [19].
The fruit yield per hectare was significantly influenced by application of zinc sulphate in squash (Table 4). The highest fruit yield per hectare (31.74t) was recorded in Z_1 (25 ppm of zinc sulphate) treatment. The lowest value of fruit yield per hector (22.91 t) was found in Z_0 (control).

Combined application of salicylic acid and zinc sulphate significantly influenced on the fruit yield per hectare of squash production ((Table 5). The highest fruit yield per hectare (47.57 t) was obtained from the S_2Z_1 (90ppm salicylic acid and 25 ppm of zinc sulphate) treatment combinations which was statistically similar to S_1Z_1 (60ppm salicylic acid and 25 ppm of zinc sulphate) treatment combination and the lowest fruit yield per hectare (18.09 t) was observed from the Z_0S_0 (control) treatment combination which was statistically similar to S_0Z_2 treatment combination

3.11 Economic analysis

Economic analysis is the major criteria to evaluate the best treatments which were economically sound and that can be accepted by farming community. The cost of cultivation, gross and net returns in addition to benefit cost ratio of different treatment combinations studied in the present investigation is presented in (Table 6). The highest gross return (1189425 BDT) was obtained from S_2Z_1 (90 ppm of salicylic acid and 25 ppm of zinc sulphate) while the lowest gross return (452325 BDT) was obtained from S_0Z_0 (control) treatment combination. The highest net return (881669 BDT) was obtained from S_2Z_1 (90 ppm of salicylic acid and 25 ppm of zinc sulphate) while the lowest net return (145649 BDT) was obtained from S_0Z_0 (control) treatment combination. The highest benefit cost ratio (3.86) was obtained from S_2Z_1 (90 ppm of salicylic acid and 25 ppm of zinc sulphate) while the lowest benefit cost ratio (1.47) was obtained from S_0Z_0 (control) treatment combination.

Table 6. Cost and return analysis considering different levels of salicylic acid and zinc sulphate of squash.

Treatment combinations	Yield (t/ha)	Gross return (BDT/ha)	Total cost of production (BDT/ha)	Net return (BDT/ha)	Benefit cost ratio (BCR)
S_0Z_0	18.09	452325	306676	145649	1.47
S_0Z_1	30.66	766500	306796	459704	2.50
S_0Z_2	21.78	544500	306916	237584	1.77
S_1Z_0	23.60	590075	307336	282739	1.92
S_1Z_1	43.47	1086825	307456	779369	3.53
S_1Z_2	34.56	864175	307576	556599	2.81
S_2Z_0	27.03	675925	307636	368289	2.20
S_2Z_1	47.57	1189425	307756	881669	3.86
S_2Z_2	38.90	972500	307876	664624	3.16

Here, S_0 = No salicylic acid (control), S_1 = 60 ppm of salicylic acid, S_2 = 90 ppm of salicylic acid, And Z_0 = No zinc sulphate (control), Z_1 =25 ppm of zinc sulphate, Z_2 = 50 ppm of zinc sulphate

CONCLUSION

This study revealed that different levels of salicylic acid and zinc sulphate have a positive effect on growth and yield of squash. In case of fruit yield of squash, the combination of S_2 (90 ppm of salicylic acid) treatment which is statistically similar to S_1 (60 ppm of salicylic acid) along with Z_1 (25 ppm of zinc sulphate) were given the better performance of all the yield contributing parameters of squash. But economic analysis revealed that the treatment combination S_2Z_1 (90 ppm of salicylic acid and 25 ppm of zinc sulphate) was economically profitable than S_1Z_1 (60 ppm of salicylic acid and 25 ppm of zinc sulphate) treatment combination for squash cultivation. So, S_2Z_1 (90 ppm of salicylic acid and 25 ppm of zinc sulphate) treatment combination can be repeated in different agro ecological zones of Bangladesh.

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