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INFLUENCE OF GIBBERELLIC ACID (GA3) ON GROWTH, FLOWERING, AND FRUIT YIELD OF CUCUMBER

M.A. Rahman, S. Sikder*, M.M. Bahadur and S.K. Pramanik

Department of Crop Physiology and Ecology, Hajee Mohammad Danesh Science and Technology University, Dinajpur 5200, Bangladesh

ABSTRACT

Growth, flowering and fruiting attributes of four cucumber varieties as influenced by GA3 was studied during March to May, 2018 at research field of Crop Physiology and Ecology Department, Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, Bangladesh. The experiment consisted of two factorsi .e. ,two growing conditions (control and foliar application of GA3); and four cucumber varieties (Shohag, Sarothi, Sufala-1 and Shila). Total eight treatment combinations were implemented in a randomized complete block design and replicated thrice. Foliar application of GA3 was found significantly superior over control in terms of different growth, flowering and fruiting behaviors of cucumber. Under foliar application of GA3, the maximum fruit yield (24.58 t ha^{-1}) was recorded in Sufala-1, whereas minimum fruit yield (19.73 t ha^{-1}) was recorded in Sarothi. Moderate fruit yield was recorded from rest of the two varieties (23.95 and 20.50 t ha^{-1} in Shila and Shohag, respectively).

Key words: Growth, flowering behavior, fruiting, GA3 and cucumber

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is a monoecious creeper, annual trailing vine vegetable and a nutritious and delicious vegetable of tropical part of the world (Bailey 1969). It is a primary source of vitamins and mineral (AVRDC 1999). In a 100 g serving, raw cucumber (with peel) contains 95% water, provides 16 kcal energy, 3.63 g carbohydrates, 1.67 g sugars, 0.50 g dietary fiber, 0.11 g fat and 0.65 g protein and supplies low content of essential nutrients, as it is notable only for vitamin K at 16% of the daily value (USDA 2019). The total world production of cucumbers is 83,753,861 metric tons whereas, in Bangladesh the total production is approximately 121,254 metric tons (FAOSTAT 2018) which is very low compared to that of other countries of the world. Lower number of female flower compare to male flower is a problem for cucumber production in Bangladesh due to high temperature and humidity but there is a scope to increase cucumber production by increasing the number of female flowers as well as fruiting through exogenous application of chemicals and plant growth regulators (PGRs).

Exogenous application of PGRs improves growth, yield and quality attributes of crop plants (Geetha *et al.* 2000); alter the sex ratio and sequence if applied at the two or four leaf stage at which the suppression or promotion of sex is possible (Hossain *et al.* 2006). PGRs such as auxin and gibberellin are found to use in low concentration to change the plant growth usually by stimulating part of the natural growth regulatory system (Dalai *et al.* 2015). Among different PGRs, GA3 have been reported to boost the growth and yield attributes in chickpea (Reja *et al.* 2020), cucumber (Kumar and Wehner 2012; Kadi *et al.* 2018), squash (Shafeek *et al.* 2016), bitter gourd (Hossain 2004), fenugreek (Alagukannan and Vijaykumar 2003) and cumin (El-Keltawi *et al.* 2000).

*Corresponding author: Email: srisikder@gmail.com, Cell phone: +8801715204206

At present, the farmers of Bangladesh have started to use various growth regulators at a very limited scale to increase the yield of their vegetables as per recommendation of some commercial trader. Some are applying PGRs exogenously to increase femaleness as well as number and quality of fruit in order to increase the production of cucumber. But they need to know about the influence of different growth regulators on different genotypes of cucumber. Keeping these facts in mind, a field experiment was conducted to examine the influence of GA3 on growth, flowering, and fruit production of cucumber and to find out the best studied variety under the foliar application of GA3.

MATERIALS AND METHODS

Location and duration: The experiment was conducted at the research field of Crop Physiology and Ecology Department, Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, Bangladesh under the Agro-ecological zone 1 (Old Himalayan Piedmont Plain) during March to May, 2018.

Experimental design, layout and treatments: The experiment was laid out in a randomized complete block design with three replications. The selected land area was divided into three equal blocks that represent replication. Each block was divided into eight plots where eight treatment combinations were randomly allotted. The unit plot size was 2.0 m × 2.0 m. The distances between plot to plot and block to block were 0.5 and 1.0 m, respectively. The treatments included two factors: 1) two growing conditions: i) control (no gibberellic acid) and ii) foliar application of gibberellic acid (300 ppm GA3) and 2) four cucumber varieties (Shohag, Sarothi, Sufala-1 and Shila).

Pit preparation, seed sowing and intercultural operations: There was one pit in every plot and the area of each pit was 25 cm × 25 cm. The pits were prepared with necessary manures and fertilizers according to cucumber cultivation manual (BARC 1997). Three seeds were sown in each pit at 1.5 to 2 cm depth and when the seedlings attained 10-15 cm height and hard enough then one healthy seedling was selected to keep in each pit and others were thinned out. Necessary intercultural operations such as weeding, stalking, vine management, irrigation and plant protection measures were taken when and as needed.

Preparation and application of GA3: To make 300 ppm solution of GA3, 300 mg of GA3 was dissolved in 10 ml of ethanol and was added with 1% Tween 20 in order to improve the spray retention. Then the solution was made up to 1000 ml by adding distilled water and shacked well to get 300 ppm. The prepared solution was applied in four installments. First spray was done at 2 to 3 leaves (fully expanded) stage of seedlings. The remaining three sprays were done at 7, 14 and 21 days after 1st spray to the leaves and twigs of the plants with a hand sprayer.

Data collection: Data were recorded on growth, flowering, and fruit yield attributes such as vine length, internodal distance, number of tendrils plant^{-1}, number of primary branches plant^{-1}, number of leaves plant^{-1}, days taken to first male and female flowering, days taken to 50% flowering, total number of male and female flowers plant^{-1}, number of fruits plant^{-1}, individual fruit weight, fruits yield plant^{-1} and fruit yield (t ha^{-1}).

Statistical analysis: The data were analyzed by partitioning the total variance with the help of a computer using STATA program (Small stata 12.0) and the mean differences were adjusted by the Tukey’s Test at 5% level of probability.

RESULTS AND DISCUSSION

Growth parameters

Vine length: The vine length of cucumber varieties varied significantly ($P < 0.01$) by the combined effect of growing conditions and cucumber varieties (Table 1). Results showed that all the varieties attained maximum vine length under GA3 compared to control. Sufala-1 produced the maximum vine length under both control and GA3 (660.70 and 674.74 cm, respectively) followed by Shila (647.13 and 665.65, respectively). Under control condition, the minimum vine length (619.90 cm) was observed in Shohag, whereas under GA3 the minimum vine length was observed in Sarothi (649.83 cm). Foliar application of GA3 during stem elongation positively affected vine length as GA3 has a positive regulatory effect on vegetative growth of plant. Growth regulators increased rate of photosynthesis activity, accelerated translocation and efficiency of utilization of photosynthase, thus resulting in the cell elongation and rapid cell division in the growing portion which ensure longest stem. Kadi *et al.* (2018) and Shafeek *et al.* (2016) also reported positive effect of GA3 on vine length of cucumber and squash, respectively that support our present findings.

Internodal distance: Combined effect of cucumber varieties and growing conditions significantly interacted ($P < 0.05$) on distance between nodes (Table 1). Under control condition, Sufala-1 produced the maximum distance between two nodes (9.50 cm) which was statistically similar to that of the Shohag (9.25 cm), whereas Sarothi produced the minimum distance between two nodes (8.17 cm). More nodal distance was observed under GA3 (9.25 to 11.13 cm) compared to control (8.17 to 9.50 cm). However, under GA3, the Sufala-1 produced maximum nodal distance (11.13 cm), while minimum nodal distance (9.25 cm) was recorded in Sarothi. Results supportive to our findings were also reported by Kadi *et al.* (2018). They reported that GA3 as well as NAA increased the distance betwwen nodes in cucumber.

Table 1. Interaction effect of variety and gibberellic acid (GA3) on vine length, number of nodes plant^{-1}, internodal distance and number of tendrils plant^{-1} of cucumber

Cucumber varieties	Growing conditions	Vine length (cm)	Internodal distance (cm)	Number of tendrils plant^{-1}
Shohag	Control	619.90e	9.25bcd	59.84d
	GA3	657.91bc	10.12abc	62.43b
Sarothi	Control	636.02d	8.17d	55.87e
	GA3	649.83c	9.25bcd	61.62bc
Sufala-1	Control	660.70ab	9.50bcd	59.92d
	GA3	674.74a	11.13a	62.08b
Shila	Control	647.13cd	9.04cd	60.36cd
	GA3	665.65ab	10.67ab	65.07a
Level of significance		**	*	**
CV (%)		7.72	10.47	4.24

In a column, means having similar letter(s) did not differ significantly at 5% level by Tukey. '' and '**' indicate significantly different at 5 and 1% level of probability, respectively.*

Number of tendrils plant^{-1}: Combined effect of growing conditions and cucumber varieties significantly influenced ($P < 0.01$) the number of tendrils plant^{-1} (Table 1). Under control condition, maximum number of tendrils plant^{-1} (60.36) was recorded from Shila variety of cucumber and minimum number of tendrils plant^{-1} (55.87) was recorded from Sarothi. Number of tendrils plant^{-1} was increased in all the varieties under foliar application of GA3 but the degree of increasing was not similar for all varieties. However, under foliar application of GA3, the maximum number of tendrils plant^{-1}

(65.07) was observed in Shila and the minimum number of tendrils plant^{-1} (61.62) was observed in Sarothi variety of cucumber. Other two varieties produced lower but statistically similar number of tendrils (62.43 and 62.08).

Number of primary branches plant^{-1}: The number of primary branches plant^{-1} of cucumber was significantly varied ($P < 0.01$) by the interaction effect of growing conditions and cucumber varieties (Table 2). Under control condition, maximum number of primary branches plant^{-1} (8.44) was found in Sufala-1 which was statistically similar to that of Shila (8.25), whereas minimum number of primary branches plant^{-1} (7.27) was recorded from Sarothi. Foliar application of GA3 increased the number of primary branches plant^{-1} in all the varieties but the magnitude of increasing was not similar for all varieties. However, under foliar application of GA3, the maximum number of primary branches plant^{-1} (9.33) was observed in Shila which was statistically similar to that of Sufala-1 (9.30) and the minimum number of primary branches plant^{-1} (8.32) was observed in Sarothi variety of cucumber. The increased number of primary branches in cucumber under GA3 application might be due to stimulatory effect of GA3 on vegetative growth of plant. The results of the present study are in a line with the results stated by Mir (2007). They reported highest number of primary branches in cucumber plant when treated with growth regulator Ripen-15.

Table 2. Interaction effect of variety and gibberellic acid (GA3) on number of primary branches plant^{-1}, number of leaves plant^{-1}, days to 1st male flowering and days to 1st female flowering of cucumber

Cucumber varieties	Growing conditions	Number of primary branches plant^{-1}	Number of leaves plant^{-1}	Days to 1st male flowering	Days to 1st female flowering
Shohag	Control	8.24bc	54.65	31.73	36.45a
	GA3	8.48b	62.69	34.06	32.47c
Sarothi	Control	7.27d	63.69	32.34	34.78abc
	GA3	8.32b	67.28	34.38	33.44bc
Sufala-1	Control	8.44b	66.50	34.73	35.79ab
	GA3	9.30a	74.81	36.40	34.47abc
Shila	Control	8.25b	60.68	33.75	35.13abc
	GA3	9.33a	69.26	37.49	33.83abc
Level of significance		**	NS	NS	*
CV(%)		12.5	9.86	6.30	4.40

In a column, means having similar letter(s) did not differ significantly at 5% level by Tukey. '' and '**' indicate significantly different at 5 and 1% level of probability, respectively. NS indicates non-significant at 5% level of probability.*

Number of leaves plant^{-1}: Number of leaves plant^{-1} was not significantly influenced by the combined effect of growing conditions and cucumber varieties (Table 2) but significantly varied by the main effect. Under control condition, Sufala-1 produced the maximum number of leaves plant^{-1} (66.50) and the minimum number of leaves plant^{-1} (54.65) was recorded in variety Shohag. All the cucumber varieties increased their number of leaves plant^{-1} under foliar application of GA3 and all the varieties produced more or less similar number of leaves. However, under GA3 applied condition, the maximum number of leaves plant^{-1} (74.81) was found in Sufala-1, whereas the minimum number of leaves plant^{-1} (62.69) was found in Shohag. The results of the present study are in a parallel with the previous investigation (Dalai *et al.* 2016 and Kadi *et al.* 2018) where they reported foliar application of GA3 increases leaf number in cucumber plant.

Flowering attributes

Days taken to 1st male flowering: Days required for 1st male flowering was not significantly influenced by the interaction effect of growing conditions and cucumber varieties (Table 2) but significantly varied by the main effect. Under control condition, maximum number of days (34.73) required for 1st male flowering was recorded from Sufala-1 and minimum number of days (31.73) required for 1st male flowering was recorded from Shohag. Foliar application of GA3 delayed in 1st male flowering in all the cucumber varieties. Under foliar application of GA3, the cucumber varieties Shohag, Sarothi, Sufala-1 and Shila attained at 1st male flowering stage about 3, 2, 2 and 4 days later, respectively compared to control. However, under GA3 applied condition, the maximum number of days (37.49) required for 1st male flowering was recorded from Shila and minimum number of days (34.06) required for 1st male flowering was recorded from Shohag variety of cucumber. Differential degree of flowering among the cucumber varieties might be due to genetic variability of cucumber plant. The results of the present study are parallel to the results reported by Farhana (2015) who concluded that application of different growth regulators *viz.* Maleic hydrazide, Silver nitrate, Ethophon and GA3 at different rate influenced flowering behavior of cucumber plant.

Days taken to 1st female flowering: Days required for 1st female flowering showed significant variation ($P < 0.05$) due to interaction effect of growing conditions and cucumber varieties (Table 2). Under control condition, maximum number of days (36.45) required for 1st female flowering was recorded from Shohag and minimum number of days (34.78) required for 1st female flowering was recorded from Sarothi. Under foliar application of GA3 all the cucumber varieties required shorter time (32.47 to 34.47 days) to attain 1st female flowering compared to control (33.78 to 36.45 days). Under Foliar application of GA3, the cucumber varieties Shohag, Sarothi, Sufala-1 and Shila attained at 1st female flowering stage about 4, 1, 1 and 2 days earlier, respectively. However, under GA3 applied condition, the maximum number of days (34.47) required for 1st female flowering was recorded in Sufala-1, while the minimum number of days (32.47) observed in Shohag. The earliness in 1st female flowering in cucumber under GA3 application might be due to effect of gibberellic acid on changing the direction of sexual differentiation in potentially male buds to female buds resulted in enhanced female flowering and reduced male flowering. The results of the present study are in an agreement with the results reported by Dalai *et al.* (2016) who concluded foliar application of GA3 influenced phenological requirement in cucumber.

Days taken to 50% male flowering: Days required for 50% male flowering significantly varied ($P < 0.05$) by the combined effect of growing conditions and cucumber varieties (Table 3). Under control condition, Sufala-1 required maximum days (48.66) to attain 50% male flowering, whereas minimum days (46.92) required for 50% male flowering was recorded from Shohag variety. Foliar application of GA3 delayed in 50% male flowering in all the cucumber varieties by 5, 1, 2 and 4 days in Shohag, Sarothi, Sufala-1 and Shila, respectively compared to control. However, under GA3 applied condition, the maximum days (52.57) required for 50% male flowering was recorded from Shila and minimum days (49.37) required for 50% male flowering was recorded from Sarothi. The delayed in 50% male flowering in cucumber under GA3 application might be due to effect of gibberellic acid on enhancing female flowering and restraining male flowering. Hossain (2004) and Shafeek *et al.* (2016) also concluded similar effect of GA3 in delaying male flowering of cucumber that supports our present findings.

Days taken to 50% female flowering: Cucumber varieties and growing conditions significantly interacted ($P < 0.01$) to influence the number of days required for 50% female flowering (Table 3). Under GA3 applied condition, all the cucumber varieties required shorter time (43.98 to 47.10 days) to attain 50% female flowering compared to control condition (50.17 to 52.32 days). Sufala-1 required maximum days (52.32) to attain 50% female flowering under control condition but 50% female flowering occurred about 9 days earlier in this variety under GA3 application. Sarothi required minimum days (50.17) to attain 50% female flowering under control condition but 50% female flowering occurred about 3 days earlier in this variety under GA3 application. In Shohag and Shila 50% female flowering was 7 days earlier under GA3 applied condition compared to control condition. However, under foliar application of GA3, Sarothi required maximum days (47.10) to attain 50% female flowering, whereas Sufala-1 required minimum days (43.98) to attain 50% female flowering. Findings consistent to the findings of the present study were also reported by Kadi *et al.* (2018), Hossain (2004) and Shafeek *et al.* (2016). Their findings exposed that foliar application of GA3 caused earliness in female flowering in cucumber plant.

Number of male flowers plant^{-1}: Number of male flowers plant^{-1} showed a statistically significant ($P < 0.01$) variation in relation to growing conditions and cucumber varieties (Table 3). Under control condition, Sufala-1 produced the maximum number of male flowers plant^{-1} (140.65) which was closely followed by Shila (139.21), while the minimum number of male flowers plant^{-1} (132.03) was recorded from Sarothi. All the cucumber varieties reduced their number of male flowers plant^{-1} under foliar application of GA3 but the magnitude of reduction was not similar for all varieties. Under GA3 applied condition, the maximum number of male flowers plant^{-1} (111.16) was found in Sufala-1 which was closely followed by Shila variety of cucumber (109.86), whereas the minimum number of male flowers plant^{-1} (98.93) was found in Shohag. Gibberellic acid changes the direction of sexual differentiation in potentially male buds to female buds. As a result, the total number of male flower was decreased in cucumber plant under the present study. Reduction of male flower due to application of gibberellic acid was also reported by Hossain (2004) in cucumber and bitter gourd.

Table 3. Interaction effect of variety and gibberellic acid (GA3) on days taken to 50% male and female flowering and number of male and female flowers plant^{-1} of cucumber

Cucumber varieties	Growing conditions	Days to 50% male flowering	Days to 50% female flowering	Number of male flowers plant^{-1}	Number of female flowers plant^{-1}
Shohag	Control	46.92c	51.78a	134.94ab	46.69e
	GA3	51.19ab	44.92bc	98.93e	53.70cd
Sarothi	Control	48.52bc	50.17a	132.03b	45.80e
	GA3	49.37bc	47.10b	102.62de	52.17de
Sufala-1	Control	48.66bc	52.32a	140.65a	54.14b
	GA3	50.53ab	43.98c	111.16c	62.08a
Shila	Control	48.42bc	51.10a	139.21ab	48.19de
	GA3	52.57a	44.57c	109.86cd	54.28b
Level of significance		*	**	**	*
CV (%)		3.88	7.03	13.62	6.14

In a column, means having similar letter(s) did not differ significantly at 5% level by Tukey. '' and '**' indicate significantly different at 5 and 1% level of probability, respectively.*

Number of female flowers plant^{-1}: A statistically significant ($P < 0.05$) variation was found in number of female flowers plant^{-1} due to the interaction of growing conditions and cucumber varieties (Table 3). Under control condition, maximum number of female flowers plant^{-1} (54.14) was recorded from Sufala-1 and minimum number of female flowers plant^{-1} (45.80) was recorded from Sarothi.

Under foliar application of GA3 number of pistillate flowers plant^{-1} was promoted in all the cucumber varieties but the degree of promotion was not similar for all varieties. However, under foliar application of GA3, the maximum number of pistillate flowers plant^{-1} (62.08) was observed in Sufala-1 and the minimum number of pistillate flowers plant^{-1} (52.17) was observed in Sarothi. Other two varieties produced moderate number of pistillate flowers plant^{-1} (54.28 in Shila and 53.70 in Shohag). Results exposed that the total number of female flower was increased in cucumber plant under foliar application of GA3. This was might be due to the exogenous application of plant growth regulators can alter the sexual differentiation in floral buds. Plant growth regulators changed the direction of sexual differentiation in potentially male buds to female buds (Yieng *et al.* 1994). Consistent result was reported by Ying *et al*. (1994) in bottle gourd. Kadi *et al.* (2018) also reported that GA3 increased the number of female flowers in cucumber and Arora *et at*. (1994) reported that GA3 increased the number of female flowers in long melon.

Fruiting characteristics

Number of fruits plant^{-1}: Combined effect of growing conditions and cucumber varieties significantly ($P < 0.05$) influenced the number of fruits plant^{-1} (Table 4). Under control condition, all the cucumber varieties produced statistically similar number of fruits plant^{-1}. Number of fruits plant^{-1} was increased in all the cucumber varieties under GA3 applied condition but the degree of increasing was diffrerent in different varieties. Under GA3 applied condition, the maximum number of fruits plant^{-1} (44.74) was recorded from Sufala-1 which was statistically at par with that of the Shila (43.84). Rest two varieties produced moderate and statistically similar number of fruits plant^{-1} (39.68 in Shohag and 38.93 in Sarothi). The results of the present study showed that fruit set could be increased by plant growth substances required for its development and enhanced fruit set. Batlang *et.al.* (2006) and Choudhury and Phatak (1959) also reported that GA3 increased number of fruits in cucumber.

Individual fruit weight: A statistically significant ($P < 0.01$) difference was observed in individual fruit weight of cucumber due to interaction of growing conditions and cucumber varieties (Table 4). Results showed that all the varieties attained more fruit weight under GA3 compared to control. Under control condition, maximum fruit weight (208.34 g) was found in Sufala-1, whereas minimum fruit weight (198.53 g) was recorded from Shohag which was statistically similar to that of Sarothi. Foliar application of GA3 promoted the individual fruit weight in all the cucumber varieties but the degree of promotion was different in different varieties. However, under foliar application of GA3, the maximum fruit weight **(**218.74 g) was observed in Sufala-1 which was statistically similar to that of Shila (217.32 g). Growth regulators increased rate of photosynthesis activity, accelerated translocation and efficiency of utilization of photosynthates, thus resulting in the cell elongation and rapid cell division in the growing portion which increase fruit length and girth results in increased fruit weight. Promotion of individual fruit weight by application of GA3 were also reported by Kadi *et al.* (2018), Shafeek *et al.* (2016) and Farhana (2015) that parallel to our findings.

Fruit yield plant^{-1}: Fruit yield plant^{-1} differed significantly ($P < 0.05$) due to interaction of growing conditions and cucumber varieties (Table 4). Results of the present study exposed that all the varieties attained maximum fruit yield plant^{-1} under GA3 application compared to control. All the cucumber varieties produced lower and statistically different fruit yield plant^{-1} under control condition. Foliar application of GA3 improved the fruit yield plant^{-1} in all the cucumber varieties but the degree of improvement was not similar in all varieties. However, under foliar application of GA3, the maximum fruit yield plant^{-1} (9.83 kg) was observed in Sufala-1 which was statistically similar to that of Shila

(9.58 kg), whereas minimum fruit yield plant^{-1} (6.78 kg) was recorded from Sarothi. Plant growth regulators increased rate of photosynthesis, accelerated translocation and efficiency of utilization of photosynthates thus resulting in the cell elongation and rapid cell division which increase fruit length and girth results in increased fruit weight. GA3 increases acceleration of reserve mobilization in fruit. It also stimulates the source capacity as well as sink size resulted in increasing of fruit weight. It could be stated that the beneficial effect of GA3 on improving fruit yield might be due to the translocation of more photo assimilates to the fruits. Results reported by Kadi *et al.* (2018), Shafeek *et al.* (2016) and Farhana (2015) are consistent with the results of our investigation. They also found that exogenous application of GA3 increased fruit production in cucumber.

Table 4. Interaction effect of variety and gibberellic acid (GA3) on fruit yield of cucumber

Cucumber varieties	Growing conditions	Number of fruits plant^{-1}	Individual fruit weight (g)	Fruit yield plant^{-1} (kg)	Fruit yield (t ha^{-1})
Shohag	Control	36.90c	198.53de	7.35d	18.38bc
	GA3	39.68b	205.16bcd	8.20bc	20.50b
Sarothi	Control	35.71c	189.00e	6.78e	16.95c
	GA3	38.93bc	201.37cde	7.89cd	19.73bc
Sufala-1	Control	39.84b	208.34b	8.37bc	20.93b
	GA3	44.74a	218.74a	9.83a	24.58a
Shila	Control	37.14c	209.37b	7.80cd	19.50bc
	GA3	43.84a	217.32a	9.58a	23.95a
Level of significance		*	**	*	**
CV (%)		9.17	8.53	11.66	12.27

In a column, means having similar letter(s) did not differ significantly at 5% level by Tukey. '' and '**' indicate significantly different at 5 and 1% level of probability, respectively.*

Fruit yield (t ha^{-1}): Fruit yield was significantly varied ($P<0.01$) by the interaction effect of growing conditions and cucumber varieties (Table 4). All the cucumber varieties improved their fruit yield (19.73 to 24.58 t ha^{-1}) under foliar application of GA3 compared to control (16.95 to 20.93 t ha^{-1}). Foliar application of GA3 increased the fruit yield in all the varieties at different magnitude. However, under GA3 applied condition, the maximum fruit yield **(**24.58 t ha^{-1}(was observed in Sufala-1 which was statistically similar to fruit yield produced by Shila (23.95 t ha^{-1}), whereas minimum fruit yield (19.73 t ha^{-1}) was recorded from Sarothi. Gibberellic acid significantly influenced both the vegetative and reproductive growth especially the flowering behavior of cucumber plants. It increased the femaleness and promoted the number, size and weight of fruit plant^{-1} which ensured improved fruit yield plot^{-1} resulted in increased in final yield of cucumber. Kadi *et al.* (2018), Shafeek *et al.* (2016), Farhana (2015) and Dalai *et al*. (2016) also observed positive effect of GA3 on fruit yield which support our findings of the present study.

CONCLUSION

The overall results of the present investigation indicated that foliar application of gibberellic acid (GA3) had a progressive effect on growth, flowering, and fruit production behavior of cucumber. Among the four varieties, Sufala-1 performed better under foliar application of GA3. However, further studies are needed to draw precise conclusion regarding the usefulness of different concentration of GA3 in cucumber production from economic point of view.

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