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# Development and Maintenance of Gynoecious Lines of Cucumber (*Cucumis sativus* L.)

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## ABSTRACT

The study aimed to develop gynoecious lines of cucumber (*Cucumis sativus* L.) by isolating, selfing and evaluating of selfed progenies from original populations and to maintain these lines by using chemicals to induce staminate flower for genetically selfing. Two $F_1$ cucumber cultivars of long type (Seminis-1 and Seminis-2) and three short type (Siminis-3, Micro-c and Bingo) from Thailand and three OP cultivars of long type (Long Green, Kusle and Bhakatpur Local) from Nepal were evaluated for gynoecious sex expression. Among the $F_1$ populations, only Bingo expressed gynoecious type for 5% and the rest were predominantly gynoecious sex type. Open-pollinated populations only expressed monoecious sex type. During the process of gynoecious line development through inbreeding and plant-to-row selection it took three consecutive selfing generation ($S_3$) for complete gynoecious development of SE1-G (long) and SE3-G (short) lines which were isolated from the original population of Seminis-1 and Seminis-3 respectively. Among the used chemical, silver nitrate ($AgNo_3$) was found statistically significantly superior over gibberellic acid ($GA_3$) and silver thiosulfate ($Ag(S_2O_2)_2$) for effective staminate flower induction for the maintenance of gynoecious lines. The highest sex ratio (M/F) 0.80:1 in SE1-G line and 0.89:1 in SE3-G line was observed by first lateral chemical application from the chemical silver nitrate 400 and 300 ppm applied twice respectively which confirm the highest possibility of flower synchronization.


**Key words:** sex expression, gynoecious, development, maintenance and cucumber

## INTRODUCTION

Hybrid varieties of cucumber are predominantly used in the production system of many developed and developing countries. The proportion of hybrid varieties is continuously increasing and thus, gynoecious lines of cucumber are important for hybrid seed production.

Sex inheritance plays an important role in cucumber hybrid breeding. Several researchers have worked on sex expression of cucumbers and reported that it was genetically determined but could be modified by growth substance application and also environmental factors (Krishnamoorthy, 1975; Lower and Edwards, 1986; Kalloo, 1988). Considering the above factors many combinations of hybrid seed production have been proposed and recommended using gynoecious parents. Despite of all efforts, sex expression variation of commercial hybrids is still a problem in cucumber cultivation (Lower and Edwards, 1986).

At present, interesting in stabilizing the gynoecious character and development of stable gynoecious inbred parents have been intensified

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and become a common goal of numerous hybrid breeding programs. Therefore this study was conducted with the following objectives.

1. To study on the consisting of gynoecious plants in promising population.

2. To isolate gynoecious lines from the promising population.

3. To find out and appropriate chemical and concentration for staminate flower induction on gynoecious lines for the purpose of line maintenance.

4. To search an effective method in line maintenance through selfing pollination.

## MATERIALS AND METHODS

All the experiments under this study were conducted at Horticulture experiment field of Kasetsart University during December 1999 to February 2001.

### 1. Sex expression in original population and line isolation

Five cultivars of long cucumber namely Seminis-1 (SE1) and Seminis-2 (SE2) and Long Green (LG), Kusle (K) and Bhakatpur Local (BL) together with three short cultivars such as Seminis-3 (SE3), Micro-c (MC) and Bingo (BG) were evaluated the sex expression. Cucumber plants were grown in 15 cm plastic pots for a preliminary study. Bingo and Seminis-2 were sown on December 15, 1999 Bhakatpur Local, Kusle and Long Green were sown on January 8,2000. Seminis-1, Seminis-3 and Micro-c were sown on February 2, 2000

Plants were examined pistillate expression at first five nodes and node order (Lower and Edwards, 1986) and individual plant was classified and recorded gynoecious, predominantly gynoecious and monoecious sex type percentage (Staub and Kipper, 1985; Staub et al. 1986 and Steele and Torrie, 1969).

The outstanding populations of long and short cucumber were considered to isolate $S_1$ lines. The isolation of gynoecious and predominantly gynoecious lines were treated with 200-400 ppm silver nitrate ($AgNo_3$) to induce staminate flowers to facilitate genetically selfing. Selected lines were isolated by plant-to-row selection up to $S_2$ and $S_3$ selfing generations and statistically analyzed by Chi-square contingency tables (Steele and Torrie, 1969), in order to obtain 100% gynoecious plants in the population and were used for succeeding experiments.

### 2. Chemical induction of staminate flowers for the maintenance of gynoecious lines

Thirteen treatments including control treatment were evaluated under randomized block design in four replications. Two concentrations of cach chemical i.e. $GA_3$ (gibberellic acid) 500 and 1000 ppm, SN (silver nitrate) 200 and 400 ppm and STS (silver thiosulfate) 6 and 9 mM were applied once or twice and only water was the control treatment. The first chemical application started at 23 days after sowing and subsequent application at 7-day interval. All chemical solutions were prepared with deionized water and applied about 5 ml./plant.

Two plants for each replication were grown in each 15cm plastic pot. Seeds of these plants were sown on November 22, 2000. Number of induced staminate flowers per plant, the position of the first staminate flowers, days to flowering and phytotoxicity caused by chemical applications were recorded for analysis. Phytotoxic rating was respectively scored as <1. 1-2, 2-3 and > 3-4 for less toxic, mild toxic, moderately toxic and severely toxic. Mean separation of each observation was statistically analyzed by Duncan's new multipte-range test.

### 3. Chemical application on first lateral of gynoecious lines for flower synchronisation

Seven treatments including control with SE1-G and SE3-G lines of cucumber were evaluated under this experiment. The SN 400 and 300 ppm were applied once and twice at 7-day interval and

SN 200 ppm was applied twice and four times at subsequent 3-day intervals on first lateral axes of the plants. The experiment was laid out as a randomized compete block design with four replications.

Two plants in each replication were grown in 15 cm plastic pot. Secds were sown on Dec 7, 2000 and plants were decapitated at three weeks after sowing in order to promote branching. The first application was done on Jan 2, 2000. The male and female flowers bloomed per day on treated and untreated axes were separately recorded and sex ratio was calculated for maximum flower synchronization.

## RESULTS

### 1. Studies of original population and line isolation

### 1.1 Population comprising gynoecious plants

Among long cucumber cultivars, the most deserving population was Seminis-1 which expressed 35% predominantly gynoecious sex type and the remaining cultivars only expressed 100% monoecious sex type (Table 1). All short cucumber cultivars comprised predominantly gynoecious sex type and only Bingo expressed 5% gynoecious sex type (Table 1).

### 1.2 The increasing percentage of gynoecious plants over generations

Significantly increasing of gynoecious plant percentage $S_2$ generation was observed in all the cultivars (Table 2). The two highest pencentages were 85% in SE1-$S_2$ (long cucumber) and 95% in SE3-$S_2$ (short cucumber) from original populations 35 and 30% respectively (Table 2).

The 100% gynoecious populations in $S_3$ generation were obtained as SE1-G and SE3-G lines (Figure 1). Gynoecious plants of these lines were maintained by selfing and the bulked seeds of each $S_3$ line was used for the experiment on gynoecious line maintenance.

1. Mean separation in column by "chi-square contingency" test indicates differences between generations in gynoecious plants at 95% confidence.

2. Percentage of gynoecious plants in S2 selfing generation was found significant increased at 95% confidence

3. Within the bracket first figure is % of gynoecious plants and second is predominantly gynoecious plants. Both sex types formed into one gynoecious sex type for the analysis.

**Table 1** Percentage of sex types in the original population of cucumber.

| Source | Status | Type | Sowing date | Total no. of plants | Sex types: Gynoecious (%) | Sex types: Predominantly gynoecious (%) | Sex types: Monoecious (%) |
|---|---|---|---|---|---|---|---|
| Seminis-1 (SE1) | $F_1$ | Long | 21.02.00 | 20 | 0 | 35 | 65 |
| Seminis-2 (SE 2) | $F_1$ | Long | 15.12.99 | 20 | 0 | 0 | 100 |
| Long Green (LG) | $O_p$ | Long | 8.01.00 | 20 | 0 | 0 | 100 |
| Kusle (K) | $O_p$ | Long | 8.01.00 | 20 | 0 | 0 | 100 |
| Bhakatpur Local (BL) | $O_p$ | Long | 8.01.00 | 20 | 0 | 0 | 100 |
| Seminis-3 (SE 3) | $F_1$ | Short | 21.02.00 | 20 | 0 | 0 | 100 |
| Bingo (BG) | $F_1$ | Short | 15.12.99 | 20 | 5 | 10 | 85 |
| Micro-c (MC) | $F_1$ | Short | 21.02.00 | 20 | 0 | 25 | 75 |

**Table 2** Increasing percentage of gynoecious plants over selfing generations in four cultivars of cucumber.

| Selfing generations | Long cucumber % of gynoecious plants | | Short cucumber % of gynoecious plants | |
|---|---|---|---|---|
| | Seminis-1 (F1) | Long Green (OP) | Seminis-3 (F1) | Micro-c (F1) |
| $S_0$ | $35^a$ | $0^a$ | 30 | 25 |
| | (0+35) | | (0+30) | (0+25) |
| $S_1$ | $45^a$ | $0^a$ | 35 | 30 |
| | (10+35) | | (15+20) | (0+30) |
| $S_2$ | $85^b$ | $8^b$ | 95 | 50 |
| | (75+10) | | (85+10) | (20+30) |

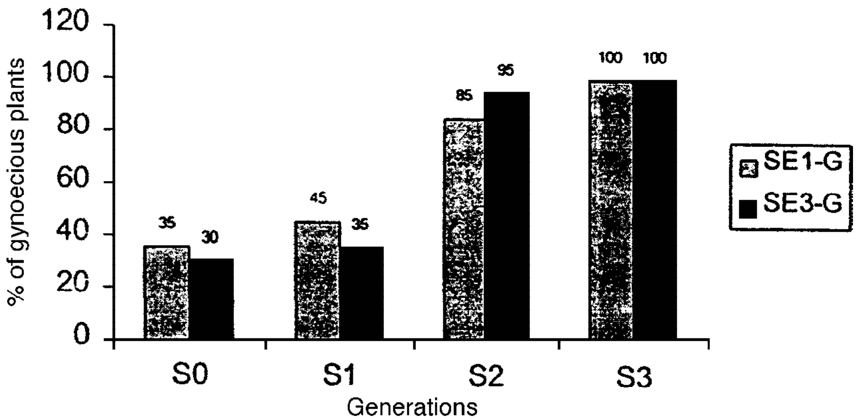


**Figure 1** Gynoecious plant percentage of selfing generations in the SE1-G and SE3-G lines of cucumber.

## 2. Chemical induction of staminate flower in two gynoecious lines

### 2.1 The case of long cucumber (SE1-G line)

#### 2.1.1 Total staminate flower induction.

Significant difference among the treatments was observed. All the cucumber plants treated with silver nitrate induced more staminate flowers than treatments treated with silver thiosulfate and gibberellic acid (Table 3). Among the silver nitrate treatment 400 ppm applied once induced highest number of staminate flower per plant (34.87) and found no significant difference with 200 ppm applied twice but significantly superior over the rest of the treatments (Table 4).

#### 2.1.2 Days to flowering

Earlier days to male flowering (30.75) of the main axis was recorded in plants treated with SN 400 ppm applied once and found significantly superior over all the treatments except SN 200 and 400 ppm applied twice. Significant difference was not observed among the treatments for days to female flowering (Table 3)

#### 2.1.3 Node number of first male flowering

Plants treated with STS 9 mM applied twice formed staminate flowers at lowest node (1.37) of the main axis and found no significant difference with treatments SN 400 ppm applied once and twice and STS 9 mM applied once but superior over the rest of the treatments (Table 3).

**2.1.4 Phytotoxic rating**

All the treatments under STS caused more phytotoxic reaction than other treatments. Treatments under GA3 caused less phytotoxic reactions, and SN had the moderate phytotoxic reaction in general (Table 3).

**2.2 The case of short cucumber (SE3-G line)**

**2.1.1 Total staminate flower induction**

Results showed the highest significant difference among the treatments for total staminate induction per plant. All the treatments of silver nitrate induced higher staminate flower than others. Among the treatment under silver nitrate, 200 ppm applied twice induced highest (42.37) staminate flowers per plant and found superior over all the treatments (Table 4).

**2.1.2 Days to flowering**

Earlier days to male flowering (30.0) was observed in plants treated with SN 400 ppm applied once and was not statistically different with treatment SN 200 ppm applied twice but was superior over all the rest treatments (Table 4). No significant difference was recorded among the treatments for days to female flowering (Table 4).

**2.2.3 Node number of first male flowering**

Treatment STS 9 mM formed the staminate flowers at lowest nodes (3.37) and found no statistical difference with treatments STS 9 mM applied once and SN 400 ppm applied twice but superior over others (Table 4).

**2.2.4 Phytotoxic rating**

All the treatments under STS caused severely phytotoxic reaction. Treatments under $GA_3$ had less phytotoxic reactions and SN had moderately (Table 4).

**Table 3** Staminate flowers per plant, days to flowering, node number at which first male flower appeared and phytotoxic rating in SE1-G line.

| Chemical | Total staminate flowers per plant | Days to flowering in the main axis | | Node of first male flowering in main axis | Phytotoxic rating |
|---|---|---|---|---|---|
| | | Male | Female | | |
| GA 500 ppm once | $2.12^{f}$ | $36.12^{d}$ | $27.25^{a}$ | $14.50^{c}$ | $0^{a}$ |
| GA 500 ppm twice | $2.25^{f}$ | $35.37^{d}$ | $27.75^{a}$ | $12.12^{d}$ | $0.25^{ab}$ |
| GA 1000 ppm once | $2.37^{f}$ | $35.12^{d}$ | $27.37^{a}$ | $14.50^{c}$ | $0.37^{ab}$ |
| GA 1000 ppm twice | $4.50^{f}$ | $33.25^{c}$ | $27.38^{a}$ | $11.25^{d}$ | $0.62^{b}$ |
| SN 200 ppm once | $30.50^{bc}$ | $32.75^{bc}$ | $27.75^{a}$ | $3.62^{bc}$ | $0.75^{bc}$ |
| SN 200 ppm twice | $32.87^{ab}$ | $31.12^{ab}$ | $27.50^{a}$ | $4.75^{c}$ | $0.87^{c}$ |
| SN 400 ppm once | $34.87^{a}$ | $30.75^{a}$ | $27.25^{a}$ | $2.62^{ab}$ | $1.12^{c}$ |
| SN 400 ppm twice | $31.50^{b}$ | $32.25^{abc}$ | $28.0^{a}$ | $1.75^{a}$ | $2.0^{b}$ |
| STS 6 mM once | $26.0^{dc}$ | $35.25^{d}$ | $28.62^{a}$ | $5.0^{c}$ | $2.75^{c}$ |
| STS 6 mM twice | $26.62^{dc}$ | $36.25^{d}$ | $27.75^{a}$ | $3.12^{b}$ | $3.25^{cf}$ |
| STS 9 mM once | $28.12^{cd}$ | $36.87^{d}$ | $27.25^{a}$ | $2.25^{ab}$ | $3.87^{fg}$ |
| STS 9 mM twice | $23.75^{c}$ | $36.62^{d}$ | $27.12^{a}$ | $1.37^{a}$ | $4.0^{g}$ |
| Control | $0^{g}$ | $0^{c}$ | $27.12^{a}$ | $0^{f}$ | $0^{a}$ |
| CV | 10.46 | 3.3 | 13.5 | 23.3 | 19.4 |

The same letter in a column are not significant difference at 5% by DMRT.

**3. Chemical application on the first lateral of two gynoecious lines for flower synchronisation**

**3.1 The case of SE1-G (long cucumber)**

**Male flower induction**

Treatment SN 400 ppm applied twice induced highest number of male flower per plant (21.62) on the treated axis and found statistically different and outstanding over all the treatments (Table 5). Significant difference was also observed among the treatments for total male flower induction and SN 400 ppm applied twice had the highest (25.0) male flower per plant and found significantly superior over others (Table 5). Control treatment did not produce staminate flowers.

**Female flowers production**

No significant difference was observed among the treatments for female flower production on the untreated axes. The lowest female flower on the treated axis (4.25) was obtained from the treatment SN 400 ppm applied twice and the highest (26.50) from the control treatment. The control treatment also produced highest number of total female flowers per plant (54.75) and lowest number (30.87) was obtained by SN 400 ppm applied twice (Table 5).

**Sex ratio (M/F)**

The maximum sex ratio (M/F) (0.80:1) was obtained from SN 400 ppm applied twice and found significantly difference over all the treatments assigned (Table 5). So there was highest possibility for synchronization of staminate and pistillate flowering.

**3.2 The case of SE3-G (Short cucumber)**

**Male flower induction**

The highest number of male flowers per plant (21.12) on the treated axis was induced by

**Table 4** Staminate flowers per plant, days to flowering, node number at which first male flower appeared and phytotoxic rating in $SE_3$-G line.

| Chemical | Total staminate flowers per plant | Days to flowering in main axis | | Node of first male flowering in main axis | Phytotoxic rating |
|---|---|---|---|---|---|
| | | Male | Female | | |
| GA 500 ppm once | 0.50$^{h}$ | 36.25$^{c}$ | 25.87$^{a}$ | 14.87$^{d}$ | 0.25$^{ab}$ |
| GA 500 ppm twice | 3.50$^{g}$ | 32.75$^{cd}$ | 25.75$^{a}$ | 10.87$^{c}$ | 0.50$^{abc}$ |
| GA 1000 ppm once | 4.62$^{fg}$ | 33.0$^{cd}$ | 26.50$^{a}$ | 11.0$^{c}$ | 0.75$^{bc}$ |
| GA 1000 ppm twice | 6.12$^{fg}$ | 31.75$^{bc}$ | 26.25$^{a}$ | 10.15$^{c}$ | 1.12$^{cd}$ |
| SN 200 ppm once | 33.37$^{c}$ | 31.62$^{ab}$ | 27.12$^{a}$ | 5.25$^{b}$ | 1.25$^{cd}$ |
| SN 200 ppm twice | 42.37$^{a}$ | 30.62$^{bc}$ | 27.0$^{a}$ | 5.37$^{b}$ | 1.75$^{dc}$ |
| SN 400 ppm once | 38.75$^{b}$ | 30.0$^{a}$ | 26.62$^{a}$ | 5.0$^{b}$ | 2.25$^{cb}$ |
| SN 400 ppm twice | 33.50$^{c}$ | 33.0$^{cd}$ | 25.75$^{a}$ | 4.25$^{ab}$ | 3.0$^{bg}$ |
| STS 6 mM once | 7.0$^{cf}$ | 33.75$^{d}$ | 26.62$^{a}$ | 5.37$^{b}$ | 3.37$^{gh}$ |
| STS 6 mM twice | 4.25$^{fg}$ | 35.25$^{c}$ | 26.12$^{a}$ | 5.12$^{b}$ | 3.75$^{gh}$ |
| STS 9 mM once | 13.37$^{d}$ | 35.25$^{c}$ | 25.75$^{a}$ | 4.66$^{ab}$ | 4.0$^{h}$ |
| STS 9 mM twice | 9.37$^{c}$ | 35.50$^{c}$ | 26.37$^{a}$ | 3.37$^{a}$ | 4.0$^{h}$ |
| Control | 0$^{h}$ | 0$^{f}$ | 26.12$^{a}$ | 0$^{c}$ | 0$^{a}$ |
| CV | 12.42 | 3.5 | 3.18 | 15.6 | 21.5 |

The same letter in a column are not significant difference at 5% by DMRT.

treatment SN 300 ppm applied twice and found statistically superior over all the treatments (Table 6). Total male flower per plant was also observed highest (23.87) by above treatment and found at par with the treatment SN 400 ppm applied one but superior over others. (Table 6).

**Female flowers production**

The lowest number of female flower on the treatment axis (2.88) was obtained from the treatment SN 300 ppm applied twice and the highest (24.5) from the control treatment. Control treatment also produced highest number of female flower per

**Table 5** Sex expression and sex ratio as expressed by number of staminate and pistillate flowers on treated and untreated axes of long cucumber (SE1-G line).

| Treatment | Treated axes | | Untreated axes | | Total | | Sex ratio M/F |
|---|---|---|---|---|---|---|---|
| | Male flowers (No.) | Female flowers (No.) | Male flowers (No.) | Female flowers (No.) | Male flowers (No.) | Female flowers (No.) | |
| SN 400 ppm once | 14.25$^{b}$ | 10.62$^{b}$ | 3.75$^{a}$ | 28.87$^{a}$ | 18.0$^{b}$ | 39.49$^{bc}$ | 0.45:1$^{bc}$ |
| SN 400 ppm twice | 21.62$^{a}$ | 4.25$^{a}$ | 3.37$^{a}$ | 26.62$^{a}$ | 25.0$^{a}$ | 30.87$^{c}$ | 0.80:1$^{a}$ |
| SN 300 ppm once | 13.50$^{b}$ | 10.25$^{b}$ | 3.75$^{a}$ | 27.25$^{a}$ | 17.25$^{b}$ | 37.50$^{cd}$ | 0.46:1$^{bc}$ |
| SN 300 ppm twice | 16.37$^{b}$ | 9.12$^{b}$ | 3.25$^{a}$ | 25.50$^{a}$ | 19.64$^{b}$ | 34.62$^{dc}$ | 0.57:1$^{b}$ |
| SN 200 ppm twice | 5.37$^{d}$ | 17.87$^{c}$ | 2.0$^{a}$ | 24.87$^{a}$ | 7.37$^{d}$ | 42.14$^{b}$ | 0.17:1$^{a}$ |
| SN 200 ppm 4 times | 9.87$^{c}$ | 12.87$^{b}$ | 2.37$^{a}$ | 27.25$^{a}$ | 12.24$^{c}$ | 40.12$^{bc}$ | 0.30:1$^{cd}$ |
| Control (H2O) | 0$^{c}$ | 26.50$^{d}$ | 0$^{b}$ | 28.25$^{a}$ | 0$^{c}$ | 54.75$^{a}$ | 0:1$^{c}$ |
| CV | 12.5 | 22.6 | 29.5 | 14.1 | 15.12 | 12.7 | 19.6 |

The same letter in a column is not significant difference at 5% by DMRT.

**Table 6** Sex expression and sex ratio as expressed by number of staminate and pistillate flowers on treated and untreated axes of short cucumber (SE3-G line).

| Treatment | Treated axes | | Untreated axes | | Total | | Sex ratio M/F |
|---|---|---|---|---|---|---|---|
| | Male flowers (No.) | Female flowers (No.) | Male flowers (No.) | Female flowers (No.) | Male flowers (No.) | Female flowers (No.) | |
| SN 400 ppm once | 164.75$^{b}$ | 8.75$^{b}$ | 3.75$^{a}$ | 22.0$^{a}$Ÿ | 20.5$^{ab}$ | 30.75$^{c}$ | 0.67:1$^{ab}$ |
| SN 400 ppm twice | 14.50$^{bc}$ | 10.37$^{b}$ | 3.50$^{a}$ | 25.37$^{a}$Ÿ | 18.0$^{bc}$ | 35.75$^{b}$ | 0.5:1$^{bc}$ |
| SN 300 ppm once | 12.50$^{cd}$ | 8.75$^{b}$ | 2.0$^{a}$ | 23.25$^{a}$Ÿ | 14.50$^{d}$ | 32.0$^{c}$ | 0.45:1$^{c}$ |
| SN 300 ppm twice | 21.12$^{a}$ | 2.88$^{a}$ | 2.75$^{a}$ | 23.87$^{a}$Ÿ | 23.87$^{a}$ | 26.75$^{d}$ | 0.89:1$^{a}$ |
| SN 200 ppm twice | 10.60$^{d}$ | 10.62$^{b}$ | 2.37$^{a}$ | 22.87$^{a}$Ÿ | 12.97$^{d}$ | 33.49$^{bc}$ | 0.38:$^{c}$ |
| SN 200 ppm 4 times | 14.25$^{bc}$ | 10.75$^{b}$ | 2.50$^{a}$ | 25.75$^{a}$Ÿ | 16.75$^{cd}$ | 36.50$^{b}$ | 0.46:1$^{c}$ |
| Control ($H_2O$) | 0$^{c}$ | 24.5$^{c}$ | 0$^{b}$ | 26.0$^{a}$Ÿ | 0$^{c}$ | 50.50$^{a}$ | 0:1$^{d}$ |
| CV | 14.3 | 15.9 | 18.8 | 17.9Ÿ | 15.0 | 15.3 | 26.5 |

The same letter in a column is not significant difference at 5% by DMRT.

plant (50.50) and the treatment SN 300 ppm applied twice had the lowest number of female flowers per plant (26.75) (Table 6).

**Sex ratio (M/F)**

The maximum sex ratio (M/F) (0.89:1) was received from treatment SN 300 ppm applied twice and found no statistical difference with treatment SN 400 ppm applied once but superior over others (Table 6). So, there was highest possibility for synchronization of staminate and pistillate flowering.

## DISCUSSION

High female population consisting higher percentage of predominantly gynoecious and the gynoecious plants were observed in the $F_1$ population as compared to the OP population. It is because of $F_1$ are the developed population from gynoecious parents.

Selfed progenies of predominantly gynoecious also that of gynoecious plants when followed by plant-to-row selection system had increased percentage of gynoecious plants in SE1 and SE3 populations. It is obvious that by inbreeding and plant-to-row selection the traits become fixed and the progeny or line approach uniformity (Agrawal, 1998)

The most effective staminate flower induction was observed on gynoecious lines treated with silver nitrate rather than silver thiosulfate and gibbereillc acid ($GA_3$). As silver ion is a potent anti-ethylene agent in cucumber and tomato (Elmo, 1976). It inhibits synthesis of ethylene and thus induce staminate flowers (Krishnamoorthy, 1975). Though $GA_3$ also inhibit the endogenous ethylene level through auxin, the induction may be more in silver ion because silver nitrate is a chemical and gibberellic acid is a kind of growth regulator (Tolla and Peterson, 1979). Lower *et al.* (1978) and Nijs and Wisser (1979) also reported for less effectiveness of $GA_3$ than silver nitrate.

Despite the staminate flower formed in the lowest nodes, the days to flowering was observed later in plants treated with silver thiosulfate compared with silver nitrate and gibberellic acid. This is mainly associated with the severe phytotoxic reaction causing plants regain growth quite late and thus affected days to flowering.

Chemical application on the first lateral axis of the plant gave high male and female sex ratio in both treated lines. Results clearly indicated that it is only due to the treated axis induced more staminate flowers while the untreated carried all female flowers.

## CONCLUSION

1. Higher percentage of predominantly gynoecious plants under this study was observed in $F_1$ population as compared to OP populations.
2. Homozygous gynoecious line could be isolated by consecutively selfing with plant-to-row selection. The gynoecious SE1-G and SE3-G lines were successfully developed under this study.
3. Silver nitrate ($AgNo_3$) was an appropriate chemical for staminate flower induction on gynoecious cucumber but the response of it’s concentration depends upon cucumber genotypes and environmental condition.
4. First lateral axis chemical application was an effective method for flower synchronization in gynoecious line maintenance through selfing pollination. The SN concentration of 400 and 300 ppm which were two times applied to SE1-G long cucumber and SE3-G short cucumber respectively were found effective concentrations in the line maintenance.

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