Effect of Ethrel and Gibberellic Acid on Growth, Flowering, Sex Ratio and Yield to Luffa Plant

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ABSTRACT

The present field experiment was consummated throughout two successive seasons (2016/2017 and 2017/2018) at the nursery of Horticulture Research Institute, Agriculture Research Center, Giza, Egypt on Luffa cylindrica. The aim to study the effect of some growth regulators (ethrel and gibberellic acid) at different levels on growth, flowering and sex ratio of Luffa cylindrica on February 28th in both seasons at 4 m distance between plants. After planting, the plants were treated with the first spray after two leaves grown, and the second spray was received after 4 leaves grown, then after that the plants were treated with spraying every 21 days until June 16th. The experiment was incorporated in randomized complete design with three replications and nine treatments viz 4 concentrations each of ethrel (50, 100, 150 and 200 ppm) and GA₃ (100, 150, 200 and 250 ppm) and control i.e. tap water spray were investigated. The results emphasized that, ethrel treatments especially at 100 ppm showed beneficial effect on improving most plant traits in both seasons (stem length, stem diameter, No. of leaves/plant, No. of branches/plant, fruit length, fruit circumference and its yield). Meanwhile, GA₃ gave was less effect on plant quality and in some instances caused a decrement on some plant parameters. The obtained results exert also the great effect of treating plants with ethrel at 100 ppm for raising number of female flowers/plant; besides raising sex ratio. Also, the growth regulators used (ethrel and GA₃) caused an improvement in chemical constituents of the newly formed plants (N, P and K and chlorophyll a, b and carotenoids in both seasons). On the other hand, an economic feasibility study was made that was inferred through the economic evaluation of some economic indicators (total revenue per feddan, gross profit margin, ratio of total revenue to costs), which was calculated to evaluate the ethrel treatment at a concentration of 100 ppm and found it was achieved positive results at the level of the indicators mentioned and also it was found that it achieved high productivity per acre compared to control and other transactions. From the results, it could be recommended to foliar spraying plants with ethrel at the level of 100 ppm as such treatment proved its mastery in most cases on plant traits.

Keywords: Luffa cylindrica, Ethrel, Gibberellic acid (GA₃), Economic Feasibility

Introduction

Luffa cylindrica (Linn M. Roem), Family Cucurbitaceae is one of the important cucurbitaceous crop, grown extensively in India. The tender fruits are used as vegetable or as cooked vegetables. Besides, its use as vegetable, this gourd is utilized for various purposes (e.g. ornamental purposes, good pot holders, table mats, bathroom mats, slipper soles have been made out from the fibers). The sponge gourd Luffa cylindrica (Linn M. Roem) posses monoecious forms as well as a great diversity of the pistillate and staminate flowering ratio. In monoecious forms the production of staminate flower is far in excess of pistillate counter part. Since the yield of the crop depends upon the production of pistillate flowers, it is worth while to study the possibility of bringing about a shift in favour of such flowers, Sex ratio and thus increase the yield.

Plant growth regulators have profound influence on fruit production in cucurbits. It can modify growth and sex expression, improve fruit set and ultimately increase the yield in number of curbits. A relationship between growth substances and sex expression probably exists in these plants. Sex modification shift towards femaleness by exogenous application of auxin, gibberellins, growth retardants, other plant growth regulators (PGRs) (GA₃ and ethrel) play an important role in morphology and physiology of the plants and influence on the plant growth and morphogenesis. They should be applied in optimal concentrations in stage of application, species specificity, seasons, etc. Also, they have important roles in many processes such as germination, seedling growth and product performance.
and yield and ripening (Alkhassawnch et al., 2006). Accurately (Birader and Navalagatti, 2008) found that PGR, such as auxin and gibberellins include many aspects of plant growth and development. Seed priming with PGR, caused an increase in seed germination and seedling vigor (Chauhan et al., 2010; Jamil and Rha, 2007). In recent years, plant growth, flowering and yield have been manipulated with the help of growth regulating substances. Some PGR, have important effect on sex expression in various cucurbitaceons crops. Also, by decreasing the male or female flowers, it causes change in yield (Hilli and Vyakaranahal, 2005). PGR, are chemical materials that are used in low concentration to change the growth of plant usually by stimulating part of the natural growth regulators system. Ethrel spray at 400 ppm in four to six leaf stage significantly increased the number of female flowers per plant (35.23%) and reduced the sex ratio (3.69) compared to control (19.8 and 224.5 respectively) in cucumber (Vadigeri et al., 2001). Ethrel at 100 ppm enhanced the total yield cucumber (Thappa et al., 2011). Trailing method plays very important role in growth and quality of Cucurbitaceae family crops. Part et al. (2008) reported that GA3 increased the growth and quality of characteristics and total flowering of jujube. Asrey et al. (2001) studied the effect of seed priming with GA3 on growth and fruiting in muskmelon and reported that GA3 at 400 ppm significantly enhanced the yield when compared to control. Ethrel at 300 and 500 ppm had little effect on 1000 seed weight and seed germination was not influenced by ethrel in Cucurbita maxima (Korzeniewska and Niemirowiez, 1993). Gad et al. (1993) showed that ethrel at 225 or 300 ppm was very effective on summer squash sex expression and enhanced number of fruit per plant and total yields.

Materials and Methods
The present experiments was consummated throughout two successive seasons (2016/2017 and 2017/2018) at the nursery of Ornamental Plant and Landscape Department, Horticulture Research Institute, Agriculture Research Center, Giza, Egypt with the aim to study the effect of some growth regulators (ethrel and gibberellic acid) at different levels (ethrel at 50, 100, 150 and 200 ppm) and (GA3 at 100, 150 200 and 250 ppm) and control (i.e. tap water spray). The seeds were planted on February 28th in both seasons at 4 m apart and the growth regulators were applied as a foliar spray every 21 days commencing from 2nd and 4th leaf stage till June 16th in the two seasons. The experiment was incorporated in randomized complete design (RCD) with three replications and nine treatments viz, four concentration each of ethrel (50, 100, 150 and 200 ppm) and GA3 (100, 150 200 and 250 ppm) and control (i.e. tap water spray) were investigated.

Data collected were on vegetative growth parameters, fruit parameters (stem length (cm.), stem diameter (cm.), No. of leaves/plant, No. of branches/plant, fruit length (cm.), fruit circumference (cm.), fruit weight (g.), No. of seeds/fruit, weight of seeds/fruit (g.), No. of fruits/plant, leaf area (cm²), number of days from planting to flowering, No. of male flowers, No. of female/flowers and sex ratio% were also estimated.

Regular agricultural practices such as weeding, watering… etc were carried out whenever needed.

Chemical constituents of the plant were determined as nitrogen (Blake, 1965), phosphorus (John, 1970), and potassium (Dewis and Freitas, 1970).

Photosynthetic pigments content (chlorophyll a, b and carotenoids mg/g.f.w.) were determined according to the methods of Saric et al. (1976)

Data were statistically analyzed using SAS program (1994) and means of were compared by L.S.D. test at 5% level of probability (Snedecor and Cochran, 1980).

Results
All growth regulators treatments caused an improving in plant parameters comparing with that gained from control treatment in the two seasons.

• Growth characters:
  1- Effect of ethrel and GA3 on stem parametes:
  a- Effect of ethrel and GA3 on stem length:

Insignificant effects were observed in stem length due to the application of the different ethrel or GA3 treatments on such traits in both seasons as indicated in Table (1).
b- Effect of ethrel and GA₃ on stem diameter:

As shown from data outlined in Table (1), using ethrel at 100 ppm proved its mastery in producing the thickest stem in the two seasons. However, receiving plants GA₃ at 250 ppm recorded the lowest means in both seasons. Meanwhile, the other treatments gave an intermediate effects in this concern.

Table 1: Effect of ethrel and gibberellic acid on stem length (cm.) and stem diameter (cm.) of Luffa cylindrica during the two seasons (2016/2017 and 2017/2018)

| Stem length (cm.) | Stem diameter (cm.) |
|------------------|---------------------|
|                  | 1st Season          | 2nd Season          |
| Control          | 180                 | 208                 |
| Ethrel 50 ppm    | 265                 | 320                 |
| Ethrel 100 ppm   | 280                 | 315                 |
| Ethrel 150 ppm   | 273                 | 307                 |
| Ethrel 200 ppm   | 230                 | 327                 |
| GA₃ 100 ppm      | 277                 | 342                 |
| GA₃ 150 ppm      | 242                 | 276                 |
| GA₃ 200 ppm      | 210                 | 234                 |
| GA₃ 250 ppm      | 225                 | 275                 |
| LSD at 0.05      | 11.962              | 12.358              |

2- Effect of ethrel and GA₃ on No. of leaves/plant and No. of branches/plant:

a- Effect of ethrel and GA₃ on No. of leaves/plant

Evidently, data scored in Table (2) indicate the prevalence of receiving plants the lowest level of ethrel (50 ppm), with significant effect in the two seasons. In contrast, the lowest means were gained as a result of applying GA₃ at 200 ppm in the first season or applying GA₃ treatments at either 150 ppm or at 250 ppm in the second one.

b- Effect of ethrel and GA₃ on No. of branches/plant:

Great influence on No. of branches/plant with significant effect was observed in the two seasons due to applying ethrel treatment at 50 ppm comparing with that gained from the other treatments used in this respect. On the contrary, considerable decrease in number of branches/plant was noticed in both seasons due to treating plants with GA₃ at 250 ppm as mentioned in Table (2).

Table 2: Effect of ethrel and gibberellic acid on No. of leaves/plant and No. of branch/plant of Luffa cylindrica during the two seasons (2016/2017 and 2017/2018)

| Treatments     | No. of leaves/plant | No. of branch/plant |
|----------------|---------------------|---------------------|
|                | 1st Season          | 2nd Season          |
|                | 1st Season          | 2nd Season          |
| Control        | 19.00               | 20.00               |
| Ethrel 50 ppm  | 32.00               | 46.50               |
| Ethrel 100 ppm | 31.00               | 43.00               |
| Ethrel 150 ppm | 28.00               | 30.00               |
| Ethrel 200 ppm | 29.00               | 32.50               |
| GA₃ 100 ppm    | 28.50               | 30.50               |
| GA₃ 150 ppm    | 27.00               | 28.50               |
| GA₃ 200 ppm    | 22.00               | 29.50               |
| GA₃ 250 ppm    | 23.50               | 28.50               |
| LSD at 0.05    | 0.961               | 1.523               |
3- Effect of ethrel and GA₃ on fruit parameters:
   a- Effect of ethrel and GA₃ on fruit length:
      Considerable increment in fruit length was observed in the two seasons as a result of receiving plant ethrel treatment at the level of 100 ppm. However, the opposite was right as a result of supplying plants the highest level of GA₃ at 50 ppm in the two seasons. The other treatments, on the other side, gave intermediate effects on such trait in both seasons, as indicated in Table (3).

   b- Effect of ethrel and GA₃ on fruit circumference:
      Obviously, data exhibited in Table (3) confirm the superiority of using ethrel at 50 ppm in raising fruit circumference in the two seasons. Meanwhile, the opposite was right on such trait due to using GA₃ at 250 ppm in the two seasons, as this treatment gave the lowest means in this regard. The other treatments, on the other side, gave an intermediate effect in this respect.

   c- Effect of ethrel and GA₃ on fruit weight:
      As shown from data presented in Table (3) applying GA₃ at 100 ppm considerably increased fruit weight comparing with that gained from the most other treatments applied in the two seasons. In contrast, receiving plants ethrel at 50 ppm gave the lowest means in this respect.

Table 3: Effect of ethrel and gibberellic acid on fruit length (cm.), fruit circumference (cm.) and fruit weight (g.) of Luffa cylindrica during the two seasons (2016/2017 and 2017/2018)

| Treatments       | Fruit length (cm) | Fruit circumference (cm) | Fruit weight (g) |
|------------------|-------------------|--------------------------|-----------------|
|                  | 1st Season        | 2nd Season               | 1st Season      | 2nd Season | 1st Season | 2nd Season |
| Control          |                   |                          |                 |           |           |            |
| Ethrel 50 ppm    | 20.00             | 22.00                    | 20.00           | 22.00     | 38.00      | 42.00      |
| Ethrel 100 ppm   | 34.00             | 37.00                    | 32.00           | 43.00     | 45.00      | 47.00      |
| Ethrel 150 ppm   | 36.50             | 41.00                    | 29.00           | 41.00     | 46.50      | 59.50      |
| Ethrel 200 ppm   | 32.00             | 35.00                    | 27.00           | 33.00     | 48.00      | 58.00      |
| Ethrel 250 ppm   | 30.00             | 34.00                    | 26.50           | 30.00     | 62.00      | 75.00      |
| GA₃ 100 ppm      | 29.00             | 32.00                    | 24.50           | 27.00     | 98.00      | 110.00     |
| GA₃ 150 ppm      | 27.00             | 30.00                    | 23.50           | 25.00     | 73.00      | 88.50      |
| GA₃ 200 ppm      | 25.50             | 27.00                    | 23.00           | 24.00     | 52.50      | 69.51      |
| GA₃ 250 ppm      | 23.00             | 25.00                    | 22.00           | 23.00     | 58.50      | 79.50      |
| LSD at 0.05      | 5.602             | 6.120                    | 4.980           | 5.053     | 5.786      | 6.223      |

4- Effect of ethrel and GA₃ on No. of days from planting to flowering:
   It is clear from data outlined in Table (4) that plants which treated with GA₃ at 250 ppm took the longest period to flower in the two seasons, comparing with that gained from the other treatments. However, the opposite was right for that recorded from plants treated with ethrel at 100 ppm in both seasons, as they recorded the shortest period for flowering.

5- Effect of ethrel and GA₃ on Leaf area:
   Data presented in Table (4) indicate the superiority of applying ethrel at 200 ppm for obtaining the highest value of leaf area in both seasons. However, the opposite was right for receiving plant GA₃ at 200 ppm, which gave the least score in this concern in both seasons.

6- Effect of ethrel and GA₃ on fruit yield:
   Data exhibited in Table (4) exert the beneficial effect of applying either ethrel or GA₃ in raising No. of fruits/plant in both seasons, comparing with that gained from untreated plants (control). In this connection applying ethrel at 100 ppm was the best treatment used for increasing No. of fruits/plant with significant effect in the two seasons, followed by that gained from using ethrel at 150 and 200 ppm in both seasons. Meanwhile, all GA₃ levels succeeded also to increase No. of fruits/plant over control but with less effect comparing with that obtained from ethrel treatments in the two seasons.
The previous results indicated the great economic values resulted from using the different growth regulators of either ethrel or GA3 with the mastery of applying ethrel in raising No. of fruits/plant (fruits yield) in the two seasons.

### Table 4: Effect of ethrel and gibberellic acid on number of days from planting to flowering, leaf area (cm²) and No. fruit/plant (fruit yield) of *Luffa cylindrica* during the two seasons (2016/2017 and 2017/2018)

| Treatments         | Number of days from planting to flowering | Leaf area (cm²) | No. fruit/plant (fruit yield) |
|---------------------|-------------------------------------------|-----------------|------------------------------|
|                     | 1st Season | 2nd Season | 1st Season | 2nd Season | 1st Season | 2nd Season |
| Control             | 80.6       | 82.4       | 191.56     | 205.06     | 12.50      | 13.31      |
| Ethrel 50 ppm       | 82.5       | 84.7       | 268.96     | 290.91     | 23.52      | 24.26      |
| Ethrel 100 ppm      | 78.0       | 80.5       | 225.00     | 244.12     | 24.31      | 25.08      |
| Ethrel 150 ppm      | 86.7       | 88.3       | 256.00     | 284.93     | 22.30      | 23.41      |
| Ethrel 200 ppm      | 89.4       | 91.5       | 290.36     | 316.56     | 20.57      | 22.23      |
| GA3 100 ppm         | 86.2       | 88.6       | 163.84     | 188.02     | 18.18      | 20.71      |
| GA3 150 ppm         | 88.6       | 90.4       | 208.28     | 228.37     | 17.22      | 19.43      |
| GA3 200 ppm         | 87.2       | 89.5       | 145.93     | 165.69     | 15.82      | 16.52      |
| GA3 250 ppm         | 92.4       | 94.2       | 186.05     | 206.90     | 13.90      | 14.42      |
| LSD at 0.05         | 2.055      | 3.131      | 6.245      | 7.362      | 1.912      | 2.533      |

7- Effect of ethrel and GA3 on seeds parameters:

**a- Effect of ethrel and GA3 on number of seeds/fruit**

As indicated from data outlined in Table (5), supplying plants GA3 at 100 ppm was the best treatment used in raising number of seeds/fruit in the two seasons. The opposite was right, where ethrel was applied at 100 ppm in the two seasons as they gave the least number of seeds/fruit in the two seasons.

**b- Effect of ethrel and GA3 on weight of seeds/fruit:**

Evidently, data registered in Table (5), show the superiority of applying ethrel at 200 ppm in the two seasons, for obtaining the highest values in the two seasons. On the contrary, receiving plant ethrel at 100 ppm in the first season and 50 ppm in the second one were the poorest treatments for the effect of the different growth regulators treatments on weight of seeds of fruits in both seasons. However, the other treatments gave intermediate effects in this regard.

### Table 5: Effect of ethrel and gibberellic acid on No. of seeds/fruit and weight of seeds/fruit (g.) of *Luffa cylindrica* during the two seasons (2016/2017 and 2017/2018).

| Treatments | No. of seeds/fruit | Weight of seeds/fruit (g.) |
|------------|--------------------|---------------------------|
|            | 1st Season | 2nd Season | 1st Season | 2nd Season |
| Control    | 130.0       | 160.0       | 13.00      | 17.80      |
| Ethrel 50 ppm | 141.0   | 168.0       | 28.50      | 23.00      |
| Ethrel 100 ppm | 132.0  | 163.5       | 23.00      | 25.00      |
| Ethrel 150 ppm | 145.0  | 189.0       | 25.00      | 27.50      |
| Ethrel 200 ppm | 178.0  | 209.5       | 30.50      | 32.00      |
| GA3 100 ppm | 193.0      | 259.0       | 29.00      | 31.00      |
| GA3 150 ppm | 164.0      | 212.0       | 27.50      | 29.50      |
| GA3 200 ppm | 143.0      | 187.5       | 24.00      | 26.50      |
| GA3 250 ppm | 189.0      | 229.5       | 26.50      | 28.00      |
| LSD at 0.05 | 1.962    | 2.035       | 1.612      | 1.832      |
8- Effect of ethrel and GA$_3$ on flowering behavior:
   a- Effect of ethrel and GA$_3$ on No. of male flowers/plant:

   Obviously, data exhibited in Table (6) showed the superiority of treating plants with ethrel at the level of 100 ppm as it was the best treatment used in both seasons, as the highest values were obtained in this respect. However, the lowest records were obtained as a result of applying GA$_3$ at 250 ppm in both seasons.

   b- Effect of ethrel and GA$_3$ on No. of female flowers/plant:

   Data exhibited in Table (6) exert the beneficial effect of treating plants with ethrel at 100 ppm for raising number of female flowers plant in both seasons. Meanwhile, the lowest values of female flowers were a result of receiving plants GA$_3$ at 250 ppm. The other treatments on the other hand, gave intermediate effects in both seasons.

   c- Effect of ethrel and GA$_3$ on Sex ratio:

   Data presented in Table (6) showed the beneficial effect of supplying plants with ethrel treatment at 100 ppm in raising sex ratio value as such treatment gave rise to the utmost highest values in both seasons. In contrast, the least scores of sex ratio were a result of treating plants with GA$_3$ at 250 ppm in the two seasons.

Table 6: Effect of ethrel and gibberellic acid on male flowers, female flowers and sex ratio% of Luffa cylindrica during the two seasons (2016/2017 and 2017/2018)

| Treatments    | Male flowers |   | Female flowers |   | Sex ratio (%) |
|---------------|--------------|---|----------------|---|---------------|
|               | 1st Season   | 2nd Season | 1st Season   | 2nd Season | 1st Season   | 2nd Season |
| Control       | 231.00       | 232.50     | 12.71        | 13.94      | 5.5%          | 6.0%       |
| Ethrel 50 ppm | 296.40       | 308.47     | 36.45        | 40.71      | 12.3%         | 13.2%      |
| Ethrel 100 ppm| 300.83       | 320.70     | 40.61        | 46.50      | 13.5%         | 14.5%      |
| Ethrel 150 ppm| 290.62       | 303.62     | 34.29        | 37.98      | 11.8%         | 12.5%      |
| Ethrel 200 ppm| 279.50       | 295.05     | 30.78        | 34.50      | 11.0%         | 11.7%      |
| GA$_3$ 100 ppm| 264.30       | 278.32     | 27.75        | 32.28      | 10.5%         | 11.6%      |
| GA$_3$ 150 ppm| 251.25       | 265.39     | 24.12        | 27.37      | 9.6%          | 10.3%      |
| GA$_3$ 200 ppm| 243.11       | 255.90     | 21.39        | 24.05      | 8.8%          | 9.4%       |
| GA$_3$ 250 ppm| 232.35       | 246.69     | 19.09        | 20.96      | 8.2%          | 8.5%       |
| LSD at 0.05   | 10.334       | 11.210     | 7.355        | 8.562      | 1.834         | 1.955      |

9- Effect of ethrel and GA$_3$ on Pigments content:

Data presented in Table (7) indicate the prevalence of treating plant with Ethrel at 200 ppm for raising pigments content in both seasons, comparing with that gained from the other growth regulators used in both seasons. Meanwhile, the lowest records were a result of plants treated with ethrel at 50 ppm for chlorophyll (a) and 150 ppm of ethrel for chlorophyll (b) and carotenoids.

Table 7: Effect of ethrel and gibberellic acid on chlorophyll a, b and carotenoids (mg/g.f.w.) of Luffa cylindrica during the two seasons (2016/2017 and 2017/2018)

| Treatments    | Chlorophyll a 1st Season | 2nd Season | Chlorophyll b 1st Season | 2nd Season | Carotenoids 1st Season | 2nd Season |
|---------------|---------------------------|------------|---------------------------|------------|------------------------|------------|
| Control       | 0.324                     | 0.437      | 0.146                     | 0.153      | 0.231                  | 0.252      |
| Ethrel 50 ppm | 0.431                     | 0.542      | 0.151                     | 0.162      | 0.276                  | 0.281      |
| Ethrel 100 ppm| 0.633                     | 0.678      | 0.182                     | 0.189      | 0.282                  | 0.287      |
| Ethrel 150 ppm| 0.711                     | 0.752      | 0.131                     | 0.138      | 0.192                  | 0.199      |
| Ethrel 200 ppm| 0.823                     | 0.902      | 0.197                     | 0.199      | 0.290                  | 0.296      |
| GA$_3$ 100 ppm| 0.615                     | 0.645      | 0.164                     | 0.171      | 0.250                  | 0.265      |
| GA$_3$ 150 ppm| 0.522                     | 0.580      | 0.156                     | 0.166      | 0.255                  | 0.240      |
| GA$_3$ 200 ppm| 0.743                     | 0.886      | 0.187                     | 0.190      | 0.261                  | 0.282      |
| GA$_3$ 250 ppm| 0.689                     | 0.705      | 0.174                     | 0.181      | 0.254                  | 0.270      |
10- Effect of ethrel and GA$_3$ on Chemical constituents:

Data exhibited on the effect of the different growth regulators of different levels revealed the increment of N% due to applying GA$_3$ at 150 ppm in the first season and with applying ethrel at 100 ppm in the second one. However, the highest values of P% was a result of receiving plants GA$_3$ at 100 ppm in both seasons. Meanwhile, the highest values of K% was a result of applying ethrel at 50 ppm in both season.

Table 8: Effect of ethrel and gibberellic acid on nitrogen, phosphours and potassium% of Luffa cylindrica during the two seasons (2016/2017 and 2017/2018)

| Treatments          | N%        | P%        | K%        |
|---------------------|-----------|-----------|-----------|
| Control             | 3.356     | 3.865     | 0.458     |
| Ethrel 50 ppm       | 3.791     | 4.035     | 0.653     |
| Ethrel 100 ppm      | 3.964     | 4.324     | 0.320     |
| Ethrel 150 ppm      | 3.569     | 4.153     | 0.545     |
| Ethrel 200 ppm      | 2.827     | 3.436     | 0.537     |
| GA$_3$ 100 ppm      | 2.881     | 3.633     | 0.546     |
| GA$_3$ 150 ppm      | 4.061     | 4.267     | 0.315     |
| GA$_3$ 200 ppm      | 2.756     | 3.124     | 0.364     |
| GA$_3$ 250 ppm      | 2.636     | 3.025     | 0.607     |

Discussion

The aforementioned results of the morphological traits may lead to the following: Patel et al. (2009) experimented the effect of ethrel on sex ratio of Luffa cylindrica. They concluded that the response of different concentrations of ethrel on number of male flowers, number of female flowers and sex ratio was found significant when compared to control. The reduced level of endogenous gibberellins and increased level of auxin after ethrel spray was reported by Rudinch et al. (1972). This may be a probable reason for increasing number of female flowers, decreasing number of male flowers and then by lowering sex ratio. Further it can be supported by the hypothesis suggested by Herrison (1957) that sexual differentiation is controlled by endogenous level of auxin in regions neighbouring the flowering primordia and during the flowering formation of pistillate organs which may be favoured by high auxin level in the vicinity of differentiation primordia and of staminate organs by the low level. The above findings are in accordance with those of Pandya and Dixit (1997) on bottle gourd, Singh and Singh (1984) and Kshirsagar et al. (1995) on cucumber. The probable reason for increase the fruit length and diameter was due to respiration and photosynthesis of treated plants remained higher than the check (Audus, 1960). This may be due to greater accumulation of carbohydrates due to photosynthesis, which resulted in increasing weight and size of fruits. The another possible reason may be explained due of the report of Crane and Overbeek (1965) who stated that the sole function of fertilized ovules or seeds in relation to growth of fruit is to synthesis one or more hormones which initiate and maintain a metabolic gradient along which foods can be translocated from the parts of the plants towards the fruits. These results are in agreement with those of Arora et al. (1987) on sponge gourd and Singh and Choudhury (1989) on bottle gourd and cucumber. Ethrel significantly increased the fruit yield over control. An increase in fruit yield in treated plants may further be attributed to that plants remain physiologically more active to build up sufficient food stock for developing of flowers and fruits, hence leading to higher yield. The above results were in consonance with those of Pandy and Dixit (1997) on bottle gourd and Arora et al., (1987) on sponge gourd.

Economic feasibility

The economic evaluation of the experiments generally depends on the technical results of these experiments that have been applied, which had carried out in research stations and field experiments in different production areas. According to the results of the experiments related to the addition of growth regulators (ethrel and gibberellic acid) at different levels, And that was during two consecutive...
agricultural seasons (2016/2017) and (2017/2018), And it has been evident to increase the plant productivity of these transactions of growth regulators. (David, 1996).

However, there are several of indicators that must be taken in consideration when conducting the economic evaluation to estimate or predict the economic viability of these growth regulators, as these indicators usually reflect the economic efficiency of transactions, and the most important of these indicators are average productivity, total revenue, total costs, net revenue, Total revenue-to-cost ratio (the benefit-to-cost ratio, it equals the total monetary value of aggregate production to total feddan costs), Hinkelmann and Kempthorne, (2007) and Dean et al. (2015).

It is clear from data outlined in Table (9) that plants which treated ethrel at 100 ppm for obtaining Feddan profit that it reached about 36.13 thousand pounds / feddan due to addition ethrel at 100 ppm comparing with that gained from untreated plants (control) in 1st season, Mosbah et al., (2019).

The results also indicated the preference of the treatment of ethrel at 100 ppm on level of producing cost of the fruit, in addition to the ratio of the revenue to the costs compared to the control treatment, as well as the other transactions that depending on the feddan productivity for the treatment ethrel at 100 ppm.

As indicated from data outlined in Table (10), supplying plants ethrel at 100 ppm in 2nd season indicated an increase in feddan profitability at about 30.18 thousand pounds / feddan over its counterpart to the control treatment, That treatment is in relation to plant productivity and hence the percentage of its profit.

Table 9: Economic feasibility of ethrel 100 ppm treatment compared to untreated plants (control) for 1st season

| Transactions | No. Fruit/plant (Fruit Yield) | No. Fruit/ feddan | Average price of a Fruit | Total costs (pounds / feddan) | Total revenue (return) pounds / feddan | Net return (profit) | cost of per a Fruit (pounds) | Revenue / cost (%) |
|--------------|-------------------------------|-------------------|--------------------------|-------------------------------|----------------------------------------|---------------------|-----------------------------|------------------|
| ppm E 100    | 24.695                        | 6420.7            | 10                       | 28075                         | 64207                                  | 36132               | 4.37                        | 2.29             |
| Control      | 12.5                          | 3250.0            |                          | 27655                         | 32500                                  | 4845                | 8.51                        | 1.18             |
| Deviation from Control | 12.195 | 31707      | 31287      | -4.14                        | 1.11                                  | 97.56               | -48.61                      | 94.60            |

Table 10: Economic feasibility of ethrel 100 ppm treatment compared to untreated plants (control) for 2nd season

| Transactions | No. Fruit/plant (Fruit Yield) | No. Fruit/ feddan | Average price of a Fruit | Total costs (pounds / feddan) | Total revenue (return) pounds / feddan | Net return (profit) | cost of per a Fruit (pounds) | Revenue / cost (%) |
|--------------|-------------------------------|-------------------|--------------------------|-------------------------------|----------------------------------------|---------------------|-----------------------------|------------------|
| ppm E 100    | 25.08                         | 6520.8            | 10                       | 28075                         | 65208                                  | 37133               | 4.31                        | 2.32             |
| Control      | 13.31                         | 3460.6            |                          | 27655                         | 34606                                  | 6951                | 7.99                        | 1.25             |
| Deviation from Control | 11.77 | 30602      | 30182      | -3.69                        | 1.07                                  | 88.43               | -46.12                      | 85.61            |

The results also indicated the preference of the treatment of ethrel at 100 ppm during the two seasons on level of producing cost of the fruit, in addition to the ratio of the revenue to the costs compared to the control treatment, as well as the other transactions that depending on the feddan productivity for the treatment ethrel at 100 ppm.

From the results of the economic indicators that were calculated to evaluate the treatment of ethrel at 100 ppm on level of the two consecutive agricultural seasons (2016/2017), (2017/2018), it was found that it achieved an feddan productivity exceeding other transactions, and it also achieved positive results at the level of the indicators mentioned in the tables above, whether from total feddan revenue, total profit, or revenue / cost(%) compared to the control, and also the other transactions that depending on the per-feddan productivity for ethrel at 100 ppm.
On other hand, the total area of luff crop in Egypt season 2017/2018 was about 2.87 thousand feddan Ministry of Agriculture and Land Reclamation, (2017/2018).

**Conclusion**

It is recommended from the aforementioned that to obtain the best growth and fruiting of *Luffa cylindrica* plant should be sprayed with ethrel at 100 ppm 4 times beginning from the transplant stage with 21 days interval.

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