The Pharma Innovation Journal 2022; 11(3): 2424-2427

www.ThePharmaJournal.com

The Pharma Innovation

**ISSN (E): 2277- 7695**
**ISSN (P): 2349-8242**
**NAAS Rating: 5.23**
TPI 2022; 11(3): 2424-2427

www.thepharmajournal.com
Received: 12-01-2022
Accepted: 19-02-2022

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# Effect of plant growth regulators on yield and quality of watermelon

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**Abstract**
A field experiment entitled was carried out on instructional farm during summer season of 2019- 20. The experiment was laid out in Randomized Block Design (RBD) with three replications. The experiment included eight treatments; namely $GA_3$ (20 ppm), NAA (100 ppm), TIBA (20 ppm), Ethephon (100 ppm), $AgNO_3$ (300 ppm), MH (100 ppm), CCC (500 ppm) and control (water spray). Two sprays of plant growth regulators were done at 2nd and 4th true leaf stages. The results of experiment revealed that yield contributing characters, chlorophyll index (64.39 Spad unit), highest sex ratio (Female: Male)(1: 9.03), minimum days to first female flower appearance (33.53), minimum node at which first female flower appeared (8.60), maximum number of fruit (3.06), average weight of fruit (3.29 kg), fruit yield kg per plant (10.07 kg), fruit yield kg per plot (100.68 kg), yield per hectare (503.38 q $ha^{-1}$) were maximum in treatment (TIBA 20 ppm).
The quality attributes such as length of fruit(30.00 cm), diameter of fruit (14.83 cm), total soluble solid (8.70%), total sugar (7.88%), reducing sugar (3.60%) and non-reducing sugar (4.28%) were noted highest in TIBA 20 ppm, whereas lowest in control.

**Keywords:** Watermelon, chlorophyll index, sex ratio, PGR

## Introduction
Watermelon (*Citrullus lanatus*) is a tropical fruit, belongs to family Cucurbitaceae is a flowering plant originated from Africa particularly South Africa. It is a fruit, which is a special kind referred by botanists as a pepo, a berry that has a thick rind (exocarp) and flesh mesocarp and endocarp. Pepos are derived from an inferior ovary, and are characteristic of the Cucurbitaceae.
Watermelon (*Citrullus lanatus* Thunb.), a popular desert fruit in tropics is an important crop throughout India. It is commonly known by the various name *tarbuj, kalindi, kalingada, matira or paniphal, mathan, thannir, palampanna,* and *kalingaddi* in different part of the country (Mahala 2014) [8]. Watermelon belongs to cucurbitaceae family having 22 chromosomes. Watermelon is monoecious or andromonoecious annual sprawling over the ground. Leaves are pinnatifide. Flowers are solitary and axillary and corolla is yellow in color. Fruit is many seeded pepo with red, green, yellow or whitish flesh and white, black or reddish yellow flat seeds.
Plant growth regulators, other than nutrients, usually are organic compounds. They are either natural or synthetic compounds and are applied directly to a plant to alter its life processes or structure in some beneficial ways so as to enhance yield and improve quality. A relationship between growth substances and sex expression probably exists in these plants. During flowering period, formation of pistillate organs is favoured by high auxin level in vicinity of differentiating primordial and of staminate organs by a low level (Heslop Harrison, 1957) [6]. Various hypotheses such as determination of sex by Plant growth regulators like $GA_3$ (Gibberelic acid), Ethephon, Cycocel (CCC), MH (Maleic hydrazide), NAA (Naphthalene acetic acid), TIBA (Triidobenzoic Acid) and Silver nitrate ($AgNO_3$) are suppress the number of male flowers and increase the number of female flowers production on lateral branches and there by ultimately increase the yield and quality.

## Material and Methods
The present investigation was carried out to study the "Effect of plant growth regulators on yield and quality of watermelon". The experiment was carried out at Instructional farm, Department of Vegetable Science, Dr. PDKV, Akola during year 2018-2019. Akola is situated at 307-457 meter altitude from sea level of $20.42^0$N latitude and $72.02^0$E longitude and has marginal tropical climate.

An annual rainfall is 850 to 900 mm. The rains are received from Southwest monsoon from June– September. Akola has got hot and dry summer and moderately cool winter. During summer, maximum temperature ranges from 40 $^0$C to 45 $^0$C and 7 $^0$C to 12 $^0$C in winter as minimum temperature. While maximum relative humidity (RH) 65.7 per cent and minimum 30.12 per cent in case of winter, December was the coolest month with 8.7 $^0$C temperature. An annual minimum rainfall was recorded 521 mm. The experimental material consists of genetically pure seed of watermelon cv. Sugar queen. The recommended packages of practices were adopted to raise the crop. Total eight treatments were tried to including control in RBD and replicated thrice. The treatments were consisting of $GA_3$ (Gibberelic acid), Ethephon, Cycocel (CCC), MH (Maleic hydrazide), NAA (Naphthalene acetic acid), TIBA (Triidobenzoic Acid), Silver nitrate ($AgNO_3$) and control (water spray). The solutions were prepared from their respective stock solution using distilled water. Five plants were randomly selected for recording observation on growth and yield attributing parameters. During the experimentation regular irrigation, weeding and plant protection measures etc. were employed as per need basis of crops. Various observations like floral, yield and quality parameter in the study were taken during study period. The data were analysed with statistical method as suggested by (Gomez 1996) [4].

## Results and Discussion

### Yield parameters

**Effect of plant growth regulators on yield parameters in watermelon:** The changes in flowering parameters of watermelon affected by different growth regulators like $GA_3$, NAA, TIBA, Ethephon, $AgNO_3$, CCC, and MH presented in Table 1. Result indicates that the effect of plant growth regulators on number of male flowers, number of female flowers and sex ratio.

The data revealed that the treatment $T_3$ (TIBA 20 ppm) were recorded maximum number of male flowers (153.67) which was statistically at par with treatments $T_6$ (148.00), $T_1$ (142.33), and $T_7$ (140.00), whereas the minimum number of male flowers (118.67) recorded in $T_2$ (NAA100 ppm). The treatment $T_3$ (TIBA 20 ppm) recorded maximum number of female flowers (17.00) and was significantly superior over rest of the all treatments followed by treatment $T_4$ (Ethephon 100 ppm) (13.00), whereas, minimum number of female flowers was recorded in treatment $T_8$ (Control water spray). The treatment application with TIBA 20 ppm recorded significantly minimum female to male flower sex ratio (1:9.03) over rest of the treatments under study. The next best treatment was NAA 100 ppm which recorded (1:9.62) Female to male sex ratio. Maximum sex ratio i.e. number of female to male flower were recorded in treatment applied with MH 100 ppm (1:11.68).

The increase in the production of female flowers as affected by the treatment (TIBA 20 ppm) is in agreement with the findings of Chaudhary *et al*. (2016) [3] in watermelon. Growth regulators advanced the female flowers initiation in the present study, which might be due to increase in the metabolization of auxin substances in plant and also reduce sugar there by bringing a change in the membrane permeability. These results are in conformity with Dixit *et al.* (2001) [3] in watermelon. At the primordial stage, all flower flowers carry both

The sets of sex organ and the application of plant growth regulators induce transformation of male flower bud into female flower bud; these results are in conformity with the result earlier reported by Chaudhary *et al*. (2016) [3] in watermelon, Sinojiya *et al*. (2015) [10] in watermelon.

**Table 1:** Effect of plant growth regulators on yield parameters in watermelon

| Treatment | Days required to edible maturity (After fruit set) | Number of fruits plant$^{-1}$ | Average fruit weight (kg plant$^{-1}$) | Fruit yield per plant (kg plant$^{-1}$) | Fruit yield per plot (kg plot$^{-1}$) | Fruit Yield Hectare$^{-1}$ (q ha$^{-1}$) |
|---|---|---|---|---|---|---|
| $T_1$($GA_3$20 ppm) | 31.63 | 2.73 | 3.20 | 8.72 | 87.20 | 435.98 |
| $T_2$(NAA100 ppm) | 32.63 | 2.62 | 3.02 | 7.91 | 79.11 | 395.56 |
| $T_3$ (TIBA 20 ppm) | 31.37 | 3.06 | 3.29 | 10.07 | 100.68 | 503.38 |
| $T_4$ (Ethephon 100 ppm | 32.57 | 2.86 | 3.03 | 8.66 | 86.57 | 432.83 |
| $T_5$ ($AgNO_3$300 ppm) | 32.73 | 2.61 | 3.03 | 7.90 | 78.98 | 394.89 |
| $T_6$ (MH 100 ppm) | 32.55 | 2.60 | 3.01 | 7.83 | 78.26 | 391.29 |
| $T_7$ (CCC500 ppm) | 32.93 | 2.53 | 3.04 | 7.71 | 77.10 | 385.51 |
| $T_8$ (Control water spray) | 33.29 | 2.36 | 2.54 | 5.99 | 59.86 | 299.30 |
| 'F'test | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. |
| S.E. m.+ | 0.25 | 0.062 | 0.047 | 0.23 | 2.34 | 11.70 |
| CD at 5% | 0.75 | 0.19 | 0.14 | 0.71 | 7.07 | 35.33 |

The treatment $T_3$ i.e. TIBA 20 ppm recorded lowermost node position for initiation of 1$^{st}$ female flower initiation (8.60) over rest of the treatments under study, except treatment $T_1$ (8.63) which were at par with each other. The next best treatments were $T_2$ (8.69) and $T_6$ (8.87). The remaining treatments showed intermediate results, while treatment control recorded uppermost node position for initiation of 1$^{st}$ female flower (9.87).

The minimum days taken for initiation of first female flower (33.53) recorded in treatment $T_3$ (TIBA 20 ppm) which was statistically at par with treatment $T_6$, $T_7$ and $T_1$ the next best treatments were $T_2$, $T_4$ and $T_5$ and were at par with each other. The maximum days for initiation of first female flower (37.35) in treatment $T_2$ (NAA 100 ppm).These results confirm with Chaudhary *et al*. (2016) [3] in watermelon and Sinojiya *et al*. (2015) [10] in watermelon.

**Table 2:** Effect of plant growth regulators on yield parameters in watermelon

| Treatment | Number of male flowers | Number of female flowers | Sex ratio Female: Male | Node at which 1st female flower appeared | Days to 1st female flower appearance |
|---|---|---|---|---|---|
| $T_1$($GA_3$20 ppm) | 142.33 | 12.67 | 1:11.23 | 8.63 | 35.94 |
| $T_2$(NAA100 ppm) | 118.67 | 12.33 | 1:9.62 | 8.69 | 37.35 |
| $T_3$ (TIBA 20 ppm) | 153.67 | 17.00 | 1:9.03 | 8.60 | 33.53 |
| $T_4$ (Ethephon 100 ppm | 133.00 | 13.00 | 1:10.23 | 9.41 | 35.02 |
| $T_5$ ($AgNO_3$300 ppm) | 130.67 | 12.33 | 1:10.59 | 9.44 | 35.27 |
| $T_6$ (MH 100 ppm) | 148.00 | 12.67 | 1:11.68 | 8.87 | 33.79 |
| $T_7$ (CCC500 ppm) | 140.00 | 12.67 | 1:11.04 | 9.21 | 34.52 |
| $T_8$ (Control water spray) | 137.33 | 12.00 | 1:11.44 | 9.87 | 36.27 |
| 'F' test | Sig. | Sig. | Sig. | Sig. | Sig. |
| S.E. m.+ | 4.94 | 0.64 | 0.0053 | 0.01 | 0.79 |
| CD at 5% | 14.50 | 1.93 | 0.016 | 0.03 | 2.33 |

The data revealed that, the minimum days for edible maturity of fruit taken in treatment $T_3$ (TIBA 20 ppm) (31.37 days), which was statistically at par with treatment $T_1$ ($GA_3$ 20 ppm) (31.63 days) the maximum days required for edible maturity of fruit (33.29 days) in treatment $T_8$ (Control- water spray). The maximum number of fruits plant$^{-1}$ (3.06) was recorded in the treatment $T_3$ (TIBA 20 ppm), which was followed by treatment $T_4$ (Ethephon 100 ppm) (2.86). However, the minimum number of fruits plant$^{-1}$ (2.36) was recorded in treatment $T_8$ (Control water spray). The maximum average weight of fruit (3.29 kg plant$^{-1}$) was recorded in treatment $T_3$ (TIBA 20 ppm), which was at par with treatment$T_1$ ($GA_3$ 20 ppm) (3.20kg plant$^{-1}$), whereas, the minimum average weight of fruit (2.54kg plant$^{-1}$) was recorded in treatment $T_8$ (Control-water spray). The treatment $T_3$ (TIBA 20 ppm) (10.07 kg plant-$^{1}$) was found significantly superior over rest of the treatments followed by treatment $T_1$ ($GA_3$ 20 ppm) (8.72 kg plant$^{-1}$) However, minimum fruits yield per plant (5.99 kg plant$^{-1}$) was recorded in treatment $T_8$ (Control -water spray). It is revealed that the treatment $T_3$ (TIBA 20 ppm) (100.68 kg plot$^{-1}$) was found significantly superior over rest of the treatments followed by treatment $T_1$ ($GA_3$ 20 ppm) (87.20 kg plot$^{-1}$) However, minimum yield per plot (59.86 kg plot$^{-1}$) was recorded in treatment $T_8$ (Control-water spray). The maximum yield per hectare (503.38 q ha$^{-1}$) respectively were obtained from the treatment $T_3$ (TIBA 20 ppm), which was significantly superior over rest of the treatments followed by treatment $T_1$ ($GA_3$ 20 ppm) (435.98 q ha$^{-1}$). However, minimum yield per hectare (299.30 q ha$^{-1}$) were recorded in treatment $T_8$ (Control water spray).

The probable reason for increasing fruit yield due to TIBA treatment had suppressed number of male flowers and promoted the number of female flowers there by increased number of fruit and ultimately produced the more yield. These results are in agreement with the findings of Gopalkrishnan and Chaudhary (1978) [5] and Alikhan *et al*. (1995) [1] in watermelon and Kakaroo *et al*. (2005) [7] in bottle gourd.

**Quality parameters**

**Effect of plant growth regulators on quality parameters in watermelon:** The data revealed that the maximum diameter of fruit (14.83 cm) was recorded in treatment $T_3$ (TIBA 20 ppm), which was statistically at par with treatments $T_4$ (Ethephon 100 ppm), $T_5$ ($AgNO_3$ 300 ppm), $T_2$ (NAA 100 ppm), $T_1$ ($GA_3$ 20 ppm) i.e. 14.79 cm, 14.59 cm, 14.54 cm, 14.47 cm respectively. Minimum diameter of fruit (13.94 cm) was recorded in treatment $T_8$ (control-water spray). The maximum length of fruit (30.00 cm) was recorded in treatment $T_3$ (TIBA 20 ppm), which was statistically at par with treatments $T_4$ (Ethephon 100 ppm), $T_1$ ($GA_3$ 20 ppm) i.e. 28.33cm, 28.00 cm respectively, Minimum length of fruit (23.00cm) was recorded in treatment $T_8$ (control-water spray).

The result indicates that the total soluble solid of fruit was significantly increased by foliar application of plant growth regulators is showed in Table 3. The maximum TSS (8.70%) was recorded in treatment $T_3$ (TIBA 20 ppm) which was statistically at par with treatment $T_5$ ($AgNO_3$ 300 ppm) and $T_1$ ($GA_3$ 20 ppm) i.e. (8.55%), (8.44%) respectively, whereas, lowest TSS (8.11%) were recorded in treatment $T_8$ (Control water spray). The highest total sugar (7.88%) was recorded in treatment $T_3$ (TIBA 20 ppm) which was found statistically at par with treatments $T_2$ (NAA100 ppm) and $T_1$ ($GA_3$ 20 ppm) i.e., (7.59%) and (7.46%), whereas, the lowest total sugar (6.57%) was recorded in treatment $T_4$ (Ethephon 100 ppm). The maximum reducing sugar percentage (3.60%) were recorded in treatment $T_3$ (TIBA 20 ppm), which was found significantly superior over rest of the treatments followed by treatment$T_1$ (3.28%), whereas, lowest reducing sugar (2.07%) was recorded in treatment $T_8$ (Control water spray).The maximum non-reducing sugar (5.15%) were recorded in treatment $T_2$ (NAA 10 ppm) which was found statistically at par with treatments $T_8$ (Control), T7(CCC 500 ppm) and $T_3$ (TIBA 20 ppm) i.e., (4.75%), (4.54%) and (4.28%) respectively, whereas, the minimum non-reducing sugar (3.94%) were recorded in treatment $T_5$ ($AgNO_3$ 300 ppm).

**Table 3:** Effect of plant growth regulators on quality parameters in watermelon

| Treatment | Fruit Diameter (cm) | Length of fruit (cm) | (TSS) Total soluble solid (%) | Reducing sugar (%) | Non- reducing sugar (%) | Total sugar (%) |
|---|---|---|---|---|---|---|
| $T_1$($GA_3$20 ppm) | 14.47 | 28.00 | 8.44 | 3.28 | 4.06 | 7.34 |
| $T_2$(NAA100 ppm) | 14.54 | 26.33 | 8.39 | 3.00 | 5.15 | 8.15 |
| $T_3$ (TIBA 20 ppm) | 14.83 | 30.00 | 8.70 | 3.60 | 4.28 | 7.88 |
| $T_4$ (Ethephon 100 ppm | 14.79 | 28.33 | 8.16 | 2.53 | 4.04 | 6.57 |
| $T_5$ ($AgNO_3$300 ppm) | 14.59 | 24.33 | 8.55 | 2.88 | 3.94 | 6.82 |
| $T_6$ (MH 100 ppm) | 14.29 | 24.00 | 8.19 | 2.79 | 4.03 | 6.82 |
| $T_7$ (CCC500 ppm) | 14.24 | 27.00 | 8.35 | 2.59 | 4.54 | 7.13 |
| $T_8$ (Control water spray) | 13.94 | 23.00 | 8.11 | 2.07 | 4.75 | 6.82 |
| 'F' test | Sig. | Sig. | Sig. | Sig. | Sig. | Sig. |
| S.E. m.+ | 0.18 | 0.80 | 0.10 | 0.10 | 0.35 | 0.14 |
| CD at 5% | 0.53 | 2.42 | 0.29 | 0.30 | 1.04 | 0.42 |

The probable reason for increase in fruit diameter was due to respiration and photosynthesis of treated plants. This may be due to greater accumulation of carbohydrates owing to photosynthesis, which result in increased in diameter; these results are in close accordance with finding of Chaudhary *et al*. (2016) [2] in watermelon. The increase in TSS by application of plant growth regulators may be due to diversion of more solids towards developing fruits and might also have enhanced the conversion of complex polysaccharides into simple sugar Ravi Kher *et al*. (2005) [9].

## Conclusion

Application of plant growth regulators significantly improved the yield and quality of watermelon. From the result, it can be concluded that application of TIBA 20 ppm at 2 & 4 true leaf stage was found superior for most of treatments minimum days for first female flower appearance, produced first female flower at early node, maximum number of fruits, average fruit weight, fruit yield per plot, yield per hectare It can also be concluded that application of TIBA 20 ppm took maximum diameter of fruit, maximum length of fruit, maximum TSS (%),maximum reducing sugar percentage and highest total sugar percentage in watermelon.

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