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Original Research Article

Effect of Plant Growth Regulators on Growth and Yield of Watermelon

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A B S T R A C T

A field experiment entitled, "Effect of plant growth regulators on growth and yield of watermelon" was conducted at instructional farm Department of Vegetable Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during summer season of 2019- 2020. 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 growth characters such as length of main stem (291.10 cm), number of leaves per plant (406.47), number of branches (9.73 plant^{-1}) and inter nodal distance (6.11 cm) were maximum with GA_3 20 ppm, while found minimum in control (269.97 cm, 379.43 plant^{-1} and 8.43 plant^{-1}, respectively). As regards to 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 with TIBA 20 ppm.

Keywords

Watermelon, Plant Growth regulators, Growth, Yield

Introduction

Watermelon (*Citrullus lanatus* Thunb.) is believed to have originated in Africa particularly the South Africa and spread to other parts of world. Global area under watermelon cultivation is 37, 52,568 ha with annual production of 99,194,223 MT. and in India current status of area are 101 mha with production 2480 MT (NHB database 2018). In India Uttar Pradesh is first in area and production and Maharashtra ranks sixth, with area 6.12 mha and production is176.31 MT. Its growth is favored by long period of warm, dry weather. A temperature of 25^0 C to 30^{0}C is ideal for growth and 25^{0}C is the best for fruit setting of watermelon. Watermelon 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 by Mahala (2014). 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 the nutrients usually are the organic compound is known to be modifying growth and sex expression, improve fruit set and ultimately increase yield in a number of cucurbits. Exogenous application of plant growth regulators can alter the sequence of male and female flower, if applied at true 2-4 leaf stages, the critical stages at which suppression or promotion of either sex is possible (Hossain *et al.,* 2006).Hence, by proper manipulation of the sequence of flowering with the application of exogenous plant growth regulators the yield of cucurbits can be increased. Plant growth regulators like GA_3 (Gibberelic acid), Ethephon, Cycocel (CCC), MH (Maleic hydrazide), NAA (Naphthalene acetic acid), TIBA (Triidobenzoic Acid) 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. Silver nitrate ($AgNO_3$) as ethylene inhibitors were used to induce the male flowers in plants. Silver nitrate can transforms female flowers to bisexual flowers in monoecious melon. A plant growth regulator plays very important role to modify or control the growth behaviour of many plants by applying in very small quantity. The growth regulators can be used for controlling vegetative growth, sex modification and ultimately helps to increase the yield.

Materials and Methods

The present investigation was carried out to study the "Effect of plant growth regulators on growth and yield 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 20.42^0N latitude and 72.02^0E 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 40^0C to 45^0C and 7^0C to 12^0C 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 8.7^0C 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 studied 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 of crop. Various observations like morphological, floral and yield parameter in the study were taken during study period. The data were analysed with statistical method as suggested by (Gomez 1996).

Results and Discussion

Growth parameters

Effect of plant growth regulators on growth parameters of watermelon

All the growth parameters such as length of main stem (cm), number of leaves per plant, Number of primary branches, Inter nodal

distance (cm), Chlorophyll Index (Spad units) affected by the application of various plant growth regulators (Table 1).

The maximum length of main stem (291.10 cm) was recorded in the treatment T_1 (GA_3 20 ppm) which was statistically at par with, T_3 (290.03 cm), whereas, minimum length of main stem (269.97 cm) was recorded in treatment T_8 (Control- water spray).

Treatment T_1 (GA_3 20 ppm) showed significantly maximum number of leaves per plant (406.47) followed by treatment T_3 (TIBA 20 ppm) (400.10), whereas the minimum number of leaves (379.43) were recorded in treatment T_8 (Control- water spray).

Maximum number of primary branches (9.73), were recorded in the treatment T_1 ($GA_3$20 ppm), which was found statistically at par with treatment T_2 (NAA 100 ppm) (9.70), whereas, minimum number of primary branches (8.43) were recorded in treatment T_8 (Control water spray).

The intermodal distance was recorded maximum (6.11 cm) in treatment T_1 (GA_3 20 ppm) at 60 DAT, which was statistically at par with treatment T_2 (NAA 100 ppm) (6.05 cm), T_3 (TIBA 20 ppm), T_4 (Ethephon 100 ppm) (5.97 cm) and T_5 ($AgNO_3$ 300 ppm) (5.98 cm), Whereas, the minimum inter nodal distance (4.73 cm) was recorded in treatment T_6 (MH 100 ppm).

The maximum chlorophyll Index in leaves (64.39) was recorded in treatment T_3 (TIBA 20 ppm) which was at par with treatment T_4 (Ethephon 100 ppm) (63.17) and T_7 (CCC 500 ppm) (62.83), whereas, the minimum chlorophyll Index (45.71) was recorded in treatment T_5 ($AgNO_3$ 300 ppm).

The observed elongation of main stem with treatment GA_3 might be due to additional exogenous application of GA_3 to quantity of endogenous gibberellins like substances within the plant, causing extra stimulation of growth. This may be effect of GA_3 to enhance cell elongation and cell division. Similar results of maximum length of main stem were reported by Shantappa *et al.*, (2005) in bitter gourd. The GA_3 cause physiological modification in plants mainly, stimulate the activity of higher photosynthetic, synthesis and translocation of metabolites form the highest number of leaves per plant at 60 and 90 day after sowing. These results are in the conformity with the result reported by Chaurasya *et al.*, (2016) in watermelon

Yield parameters

Effect of plant growth regulators on yield parameters in watermelon

The data revealed that the treatment T_3 (TIBA 20 ppm) 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) were 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). Maximum sex ratio i.e. number of female to male flower were recorded in treatment applied with MH 100 ppm (1:11.68). The next best treatment was NAA 100 ppm which recorded (1:9.62) Female to male sex ratio. The treatment with TIBA 20 ppm recorded significantly minimum female to male flower sex ratio (1:9.03) over rest of the treatments under study.

The treatment T_3 (TIBA 20 ppm) recorded lowermost node position for initiation of 1st female flower initiation (8.60) treatment T_1 (8.63) was at par with T_3, While treatment control recorded uppermost node position for initiation of 1st female flower (9.87).

The minimum days taken for initiation of first female flower (33.53) in treatment T_3 (TIBA 20 ppm) which was statistically at par with treatment T_6, T_7 and T_1. The maximum days for initiation of first female flower (37.35) were observed in treatment T_2 (NAA 100 ppm). These results are in line with Chaudhary *et al.,* (2016) in watermelon.

Data in respect of days required for edible maturity after fruit set is presented in Table 2, which revealed that the minimum days for edible maturity of fruit were 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).Whereas, 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) were 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) were recorded in treatment T_8 (Control water spray). This may be due to the fact that TIBA suppressed the number of male flowers and promote the female flowers thereby increase the number of fruits and ultimately produced the more yield. These results confirm with Chaudhary *et al.,* (2016) in watermelon. It is observed from the data that 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) (3.20 kg plant^{-1}).Whereas, the minimum average weight of fruit (2.54 kg plant^{-1}) was recorded in treatment T_8 (Control-water spray).

Table.1 Effect of plant growth regulators on growth parameters in watermelon

Treatments	Length of main stem (cm)	Number of leaves	Number of primary branches	Inter nodal distance (cm)	Chlorophyll Index (Spad units)
T_1(GA_3 20 ppm)	291.10	406.47	9.73	6.11	54.16
T_2(NAA100 ppm)	277.70	381.93	9.70	6.05	59.00
T_3 (TIBA 20 ppm)	290.03	400.10	9.18	6.02	64.39
T_4 (Ethephon 100 ppm	280.50	386.47	9.33	5.97	63.17
T_5 ($AgNO_3$ 300 ppm)	277.83	384.57	9.25	5.98	45.71
T_6 (MH 100 ppm)	274.77	383.67	8.65	4.73	58.85
T_7 (CCC 500 ppm)	274.30	380.40	8.62	5.40	62.83
T_8 (Control -water spray)	269.97	379.43	8.43	5.37	60.63
'F' test	**Sig**	**Sig.**	**Sig.**	**Sig.**	**Sig.**
S.E. m.±	**1.20**	**1.87**	**0.07**	**0.20**	**0.77**
CD at 5 %	**3.62**	**5.51**	**0.19**	**0.62**	**2.32**

Table.2 Effect of plant growth regulators on yield parameters of 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	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$20 ppm)	142.33	12.67	1:11.23	8.63	35.94	31.63	2.73	3.20	8.72	87.20	435.98
T_2(NAA100 ppm)	118.67	12.33	1:9.62	8.69	37.35	32.63	2.62	3.02	7.91	79.11	395.56
T_3 (TIBA 20 ppm)	153.67	17.00	1:9.03	8.60	33.53	31.37	3.06	3.29	10.07	100.68	503.38
T_4 (Ethephon 100 ppm	133.00	13.00	1:10.23	9.41	35.02	32.57	2.86	3.03	8.66	86.57	432.83
T_5 (AgNO$_3$300 ppm)	130.67	12.33	1:10.59	9.44	35.27	32.73	2.61	3.03	7.90	78.98	394.89
T_6 (MH 100 ppm)	148.00	12.67	1:11.68	8.87	33.79	32.55	2.60	3.01	7.83	78.26	391.29
T_7 (CCC500 ppm)	140.00	12.67	1:11.04	9.21	34.52	32.93	2.53	3.04	7.71	77.10	385.51
T_8 (Control water spray)	137.33	12.00	1:11.44	9.87	36.27	33.29	2.36	2.54	5.99	59.86	299.30
'F'test	**Sig.**	**Sig.**	**Sig.**	**Sig.**	**Sig.**	**Sig.**	**Sig.**	**Sig.**	**Sig.**	**Sig.**	**Sig.**
S.E. m.±	**4.94**	**0.64**	**0.0053**	**0.01**	**0.79**	**0.25**	**0.062**	**0.047**	**0.23**	**2.34**	**11.70**
CD at 5 %	**14.50**	**1.93**	**0.016**	**0.03**	**2.33**	**0.75**	**0.19**	**0.14**	**0.71**	**7.07**	**35.33**

The treatment T_3 (TIBA 20 ppm) (10.07 kg plant-^{1}) was found significantly maximum 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).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}) was 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 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) 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 thereby bringing a change in the membrane permeability.

In conclusion, application of plant growth regulators significantly improved the growth and yield of watermelon. From the results, it can be concluded that application of GA_3 20 ppm at 2 & 4 true leaf stage was found superior for most of the growth characters like length of main stem, number of leaves plant^{-1}, number of primary branches plant^{-1} and inter nodal distance. Further, application of TIBA 20 ppm took 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 and yield per hectare.

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