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Research Article

EFFECT OF GROWTH SUBSTANCES ON GROWTH, FLOWERING, YIELD AND QUALITY ATTRIBUTES OF WATERMELON (*CITRULLUS LANATUS* THUNB MANSF.) CV. DURGAPURA LAL (RW-177-3)

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Abstract- The experiment was laid out in Randomized Block Design with ten treatments *viz*., T_1 (Control), T_2 (GA_3 10 ppm), T_3 (GA_3 20 ppm), T_4 (GA_3 30 ppm), T_5 (NAA 25 ppm), T_6 (NAA 50 ppm), T_7 (NAA 75 ppm), T_8 (TIBA 10 ppm), T_9 (TIBA 15 ppm) and T_{10} (TIBA 20 ppm). The results revealed that, the maximum length of main creeper at 60 and 90 DAS (201.78 and 309.23 cm), respectively, number of sub-creeper at 60 and 90 DAS (7.53 and 8.23) and number of leaves/plant at 60 and 90 days after sowing (244.10 and 412.68), maximum chlorophyll content at 45 and 60 days (31.38 and 36.85) and produced the maximum number of male flower (165.75) were recorded with treatment GA_3 30 ppm (T_4). The TIBA 20 ppm (T_{10}) proved to be most effective for producing the lower node number at which first female flower appears (8.25), maximum number of female flower (19.35) and lowered sex ratio (1: 7.13) and maximum number of fruits (3.00), fruit yield/plant (12.39 kg), fruit yield/ha (619.50 q/ha) and fruit length (24.32 cm). The maximum average fruit weight (4.27 kg/fruit) and fruit diameter (22.71 cm) recorded in treatment T_9 (TIBA 15 ppm).

Keywords- Flowering, GA_3, Growth, NAA, TIBA, Watermelon, Yield.

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Introduction

Watermelon (*Citrullus lanatus*) is a cucurbitaceous crop believed to the native of Africa (Thompson and Kelly, 1957) [17]. Watermelon has high nutritive value, rich in vitamin 'C' which is good for health, low in sugar and calories because of high per cent of water. In India, watermelon is grown in about 80.00 lakh ha areas with the production of 1954.00 lakh tones having productivity of 23.80 tons/ha (Anon., 2014) [2].

Plant growth regulators are 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 flowers, if applied at 2 or 4 leaf stages, the critical stage at which the suppression or promotion of either sexes is possible. Hence, by proper manipulation the sequence of flowering with the application of exogenous plant growth regulators, the yield of cucurbits can be increased. 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) [9]. The present investigation was therefore undertaken to evaluate the potentiality of GA_3, NAA and TIBA on influencing the growth and flowering of watermelon.

Materials and Methods

The experiment was laid out in RBD with four replications during summer, 2014 on Horticulture Instructional Farm, S. D. Agricultural University, Sardarkrushinagar (Gujarat). The variety Durgapura Lal (RW-177-3) was tested with ten treatments *viz*., T_1 (Control), T_2 Gibberellic acid (GA_3 10 ppm), T_3 Gibberellic acid (GA_3 20 ppm), T_4 Gibberellic acid (GA_3 30 ppm), T_5 Naphthalene acetic acid (NAA 25 ppm), T_6 Naphthalene acetic acid (NAA 50 ppm), T_7 Naphthalene acetic acid(NAA 75 ppm), T_8 2,3,5-tri-iodobenzoic acid (TIBA 10 ppm), T_9 2,3,5-tri-iodobenzoic acid (TIBA 15 ppm) and T_{10} 2,3,5-tri-iodobenzoic acid (TIBA 20 ppm). The seeds were sown at a spacing of 2 × 1 m^2 on 25th February. The application of well decomposed farm yard manure @ 20 t/ha was applied for all the experimental plots uniformly as basal application. Nitrogen @ 100 kg/ha in the form of urea was applied in two equal split doses as basal dose and 30 days after sowing. Phosphorus @ 50 kg/ha in the form of single super phosphate (SSP) and Potassium @ 50 kg/ha in the form of muriate of potash were applied as a basal dose. Standard cultural practices were followed during the entire crop period for all the experimental plots. The seedlings were sprayed with each chemical once at 2-true and 4th leaf stages. The data were recorded from five randomly selected tagged plants. All the recorded data were analyzed statistically following analysis techniques of Panse and Sukhatme (1985) [15].

Results and Discussion

Effect of GA_3, NAA and TIBA on growth parameters:

The maximum length of main creeper at 60 and 90 days after sowing was recorded in treatment T_4 (GA_3 30 ppm) *i.e.,* 201.78 cm and 309.23 cm, respectively which was statistically at par with treatment T_3 (GA_3 20 ppm), T_2 (GA_3 10 ppm) and T_6 (NAA 50 ppm) *i.e.,* 201.05, 194.85 and 187.05 cm, respectively, whereas, T_3 (GA_3 20 ppm) and T_2 (GA_3 10 ppm) *i.e.,* 299.45 and 292.13 cm at 90 days after sowing [Table-1].

The maximum number of sub-creeper/plant at 60 days after sowing (7.53) were recorded in treatment T_4 (GA_3 30 ppm) and it was statistically at par with treatment T_3 (GA_3 20 ppm) and T_2 (GA_3 10 ppm) *i.e.,* 7.00 and 6.85, respectively.

The GA_3 cause physiological modifications in the plants mainly, stimulate the activity of higher photosynthetic, synthesis and translocation of metabolites from sources of sink points (Hillie*t al.* 2010) [10]. Ingle *et al.* (2000) [11] also reported the higher length of main vine and number of sub vine in bottle gourd.

Table-1 *Effect of GA_3, NAA and TIBA on growth attributes of watermelon cv. 'Durgapura Lal (RW-177-3)*

Treatments	Length of main creeper (cm)		Number of sub-creeper/plant		Number of leaves/plant		Chlorophyll content	
	60 DAS	90 DAS	60 DAS	90 DAS	60 DAS	90 DAS	45 DAS	60 DAS
T_1(Control)	177.90	265.68	5.37	5.95	181.20	362.93	22.97	26.66
T_2 (GA_3 10 ppm)	194.85	292.13	6.85	7.30	231.85	408.68	26.13	30.23
T_3(GA_3 20 ppm)	201.05	299.45	7.00	8.00	238.35	410.00	26.31	31.07
T_4(GA_3 30 ppm)	201.78	309.23	7.53	8.23	244.10	412.68	31.38	36.85
T_5(NAA 25 ppm)	183.95	272.43	5.50	6.00	188.25	368.98	27.36	32.18
T_6(NAA 50 ppm)	187.05	273.28	5.70	6.45	187.48	371.00	30.38	34.54
T_7(NAA 75 ppm)	179.90	269.05	5.65	6.10	185.30	365.63	25.59	29.03
T_8(TIBA 10 ppm)	182.45	271.60	5.50	6.10	201.85	368.13	25.32	29.29
T_9(TIBA15 ppm)	181.15	270.80	5.55	6.35	208.65	365.98	26.38	29.56
T_{10}(TIBA 20 ppm)	177.95	268.78	5.75	6.88	211.03	365.45	27.46	31.34
S.Em. ±	6.05	9.86	0.37	0.37	7.72	13.37	1.57	1.43
C.D. at 5 %	17.56	28.61	1.07	1.07	22.41	38.80	4.57	4.15

The highest number of leaves/plant at 60 and 90 days after sowing (244.10 and 412.68, respectively) was recorded in treatment T_4 (GA_3 30 ppm) which was statistically at par with treatment T_3 (GA_3 20 ppm) and T_2 (GA_3 10 ppm) *i.e.* 238.35 and 231.85, 410.00 and 408.68, respectively. These results are in conformity with the findings of Mishra *et al.* (1972) [13] in bottle gourd, Dixit *et al.* (2001) [7] in watermelon and Chovatia *et al.* (2010) [5] in bitter gourd.

The maximum chlorophyll content in leaves at 45 days after sowing (31.38) were recorded in treatment T_4 (GA_3 30 ppm) and which was statistically at par with treatment T_6 (NAA 50 ppm), T_{10} (TIBA 20 ppm) and T_5 (NAA 25 ppm), *i.e.,* 30.38, 27.46 and 27.36, respectively. The maximum chlorophyll content in leaves at 60 days after sowing (36.85) were recorded in treatment T_4 (GA_3 30 ppm) and which was statistically at par with treatment T_6 (NAA 50 ppm) *i.e.,* 34.54. Treatment T_1 (Control) recorded minimum length of main creeper, number of sub creeper and leaves, first female flower appearance and chlorophyll content [Table-1].

The chlorophyll have been rightly designated as "pigments of life" because of their central role in living system responsible for harvesting sunlight and transforming its energy in to biochemical energy essential for life on earth [4].

Effect of GA_3, NAA and TIBA on flowering parameters:

The minimum node number at which first female flower appears (8.25) was recorded in treatment T_{10} (TIBA 20 ppm) which was statistically at par with treatment T_9 (TIBA 15 ppm) *i.e.,* 9.58. These results are conformity with those of Arora *et al.* (1987) [3] in ridge gourd and Kakroo *et al.* (2005) [12] in bottle gourd.

The minimum number of days taken for initiation of first female flower (46.78 days) was recorded in treatment T_{10} (TIBA 20 ppm) and treatment T_1 (Control) recorded maximum days for initiation of first female flower *i.e.,* 53.70 days. The minimum number of days for fruit setting recorded with treatment T_{10} (TIBA 20 ppm) *i.e.,* 48.75 days and it was statistically at par with treatment of T_9 (TIBA 15 ppm) and T_8 (TIBA 10 ppm) *i.e.,* 49.03 and 49.85.

These results are conformity with those of Wittwar and Hillyer (1954) [18] in cucumber and Patel (1997) [16] in watermelon.

Treatment T_{10} (TIBA 20 ppm) recorded maximum number of female flower/vine *i.e.,* 19.35 which was statistically at par with T_9 (TIBA 15 ppm), T_4 (GA_3 30 ppm), T_8 (TIBA 10 ppm) *i.e.,* 18.58, 18.50 and 18.33, respectively. T_4 (GA_3 30 ppm) recorded maximum number of male flowers per vine *i.e.,* 165.75, which was statistically at par with treatment T_3 (GA_3 20 ppm) and T_2 (GA_3 10 ppm) *i.e.,*165.18 and 153.33, respectively [Table-2].

Table-2 *Effect of GA_3, NAA and TIBA on flowering parameters of watermelon cv. 'Durgapura Lal (RW-177-3)*

Treatments	Node number at which first female flower appears	Days taken for appearance of first female flower	Days taken for fruit setting	Number of female flowers	Number of male flowers	Sex ratio (female: male)
T_1(Control)	12.00	53.70	55.50	11.15	124.85	1:11.19
T_2 (GA_3 10 ppm)	13.13	50.48	52.60	16.25	153.33	1:9.43
T_3(GA_3 20 ppm)	13.05	50.55	52.95	16.43	165.18	1:10.06
T_4(GA_3 30 ppm)	14.03	50.80	53.05	18.50	165.75	1:8.96
T_5(NAA 25 ppm)	13.18	53.03	55.23	13.95	128.90	1:9.24
T_6(NAA 50 ppm)	12.05	52.55	55.25	14.50	123.15	1:8.49
T_7(NAA 75 ppm)	11.85	51.60	53.70	13.70	117.38	1:8.57
T_8(TIBA 10 ppm)	10.48	47.48	49.85	18.33	133.25	1:7.27
T_9(TIBA15 ppm)	9.58	46.98	49.03	18.58	133.78	1:7.20
T_{10}(TIBA 20 ppm)	8.25	46.78	48.75	19.35	137.95	1:7.13
S.Em. ±	0.70	1.78	1.21	0.99	6.38	0.51
C.D. at 5 %	2.03	NS	3.51	2.88	18.53	1.49

TIBA decreased vine length and resulted in production of more primary branches on which female flowers appeared in large number (Gopalkrishnan and Chaudhury, 1978) [8].

The lowest sex ratio (female: male) was recorded with treatment of T_{10} (TIBA 20 ppm) *i.e.,* 1: 7.13 through it was statistically at par with treatment T_9 (TIBA 15 ppm), T_8 (TIBA 10 ppm), T_7 (NAA 75 ppm) and T_6 (NAA 50 ppm) *i.e.,* 1: 7.20, 1: 7.27, 1: 8.57 and 1: 8.49 respectively [Table-2]. According to Gopalkrishnan and Chaudhury (1978) [8], the lower the node number of the first female flower, the lower is the male : female ratio, it was evident that in the present studies the vine treated with TIBA 20 ppm the first female flower appeared at the lowest node and the male : female flower ratio was also lowest. These results are in agreement with the findings of Patel (1997) [16] in watermelon. Similar response of TIBA on the sex ratio has been reported by Wittwar and Hillyer (1954) [18] in cucumber.

Effect of GA_3, NAA and TIBA on yield parameters:

Treatment T_{10} (TIBA 20 ppm) recorded maximum numbers of fruits *i.e.,* 3.00 and which was statistically at par with treatment T_9 (TIBA 15 ppm) *i.e.,* 2.70. This may due to the fact that TIBA suppressed the number of male flowers and promoted number of female flowers there by increased number of fruits and ultimately produced the more yield (Gopalkrishnan and Chaudhary, 1978) [8].

The maximum average fruit weight (4.27 kg/fruit) recorded in treatment T_9 (TIBA 15 ppm) which was statistically at par with treatment T_{10} (TIBA 20 ppm), T_8 (TIBA 10 ppm), T_4 (GA_3 30 ppm), T_6 (NAA 50 ppm) and T_7 (NAA 50 ppm) *i.e.,* 4.13, 3.98, 3.96, 3.88 and 3.88, respectively [Table-3].

Treatment T_{10} (TIBA 20 ppm) produced highest fruit yield/plant *i.e.,* 12.39 kg/plant and fruit yield/ha (619.50 q/ha).The probable reason for increased fruit yield due to TIBA treatment was suppressed number of male flowers and promoted number of female flowers there by increased number of fruits and ultimately produced the more yield. These results are in agreement with the findings of Gopalkrishnan and Chaudhary (1978) [8] and Alikhan *et al.* (1985) [1] in watermelon and Kakroo *et al.* (2005) [12] in bottle gourd.

Table-3 *Effect of GA_3, NAA and TIBA on yield and yield attributes of watermelon cv. 'Durgapura Lal (RW-177-3)*

Treatments	Days taken from fruit set to edible maturity	Number of fruit/plant	Average fruit weight (kg)	Fruit yield/net plot (kg)	Fruit yield/ha (q)
T_1(Control)	33.10	2.02	3.48	35.113	351.13
T_2 (GA_3 10 ppm)	32.35	2.45	3.82	46.875	468.75
T_3(GA_3 20 ppm)	32.65	2.50	3.83	47.850	478.50
T_4(GA_3 30 ppm)	32.55	2.45	3.96	48.450	484.50
T_5(NAA 25 ppm)	33.55	2.18	3.80	41.363	413.63
T_6(NAA 50 ppm)	32.25	2.20	3.88	42.675	426.75
T_7(NAA 75 ppm)	33.20	2.10	3.88	40.700	407.00
T_8(TIBA 10 ppm)	31.60	2.55	3.98	50.825	508.25
T_9(TIBA15 ppm)	30.68	2.70	4.27	57.725	577.25
T_{10}(TIBA 20 ppm)	30.18	3.00	4.13	61.950	619.50
S.Em. ±	1.20	0.14	0.13	0.59	29.67
C.D. at 5 %	NS	0.41	0.39	1.72	86.11

Effect of GA_3, NAA and TIBA on quality parameters:

Treatment T_9 (TIBA 15 ppm) recorded maximum fruit diameter *i.e.,* 22.71 cm which was statistically at par with treatment T_{10} (TIBA 20 ppm), T_8 (TIBA 10 ppm), T_4 (GA_3 30 ppm), T_3 (GA_3 20 ppm) and T_2 (GA_3 10 ppm), *i.e.,* 22.51, 21.52, 21.83, 21.81, and 21.31 cm, respectively [Table-4]. The probable reason for increase in fruit diameter was due to respiration and photosynthesis of treated plants. This may due to greater accumulation of carbohydrates owing to photosynthesis, which resulted in to increased diameter. These results were in close accordance with findings of Pandya (1995) [14] in bottle gourd.

Treatment T_{10} (TIBA 20 ppm) recorded maximum fruit length *i.e.,* 24.32 cm, which was statistically at par with treatment T_9 (TIBA 15 ppm), T_8 (TIBA 10 ppm), T_2 (GA_3 10 ppm) and T_4 (GA_3 30 ppm), *i.e.,* 24.30, 23.64, 22.30 and 22.27 cm, respectively. These effects may be explained in light of the report of Cran and Overbreak (1965) [6] who suggested that the sole function to growth of fruits depend upon foods, which can be translocated from parts of plants towards the fruits. Total soluble solids, reducing sugars (%), non-reducing sugars (%) and total sugars (%) content in fruit influenced by different treatments was found to be non significant results.

Table-4 *Effect of GA_3, NAA and TIBA on quality parameters of watermelon cv. 'Durgapura Lal (RW-177-3)*

Treatments	Diameter of fruit (cm)	Length of fruit (cm)	TSS (°Brix)	Reducing sugars (%)	Non-Reducing sugars (%)	Total sugars (%)
T_1(Control)	19.47	20.76	10.63	3.41	4.03	7.44
T_2 (GA_3 10 ppm)	21.31	22.30	10.70	3.43	4.23	7.66
T_3(GA_3 20 ppm)	21.81	21.64	10.78	3.55	4.30	7.85
T_4(GA_3 30 ppm)	21.83	22.27	10.90	3.55	4.40	7.95
T_5(NAA 25 ppm)	19.60	21.02	10.65	3.44	4.25	7.69
T_6(NAA 50 ppm)	19.77	21.70	10.85	3.49	4.40	7.89
T_7(NAA 75 ppm)	19.81	21.69	10.75	3.45	4.04	7.49
T_8(TIBA 10 ppm)	21.52	23.64	10.73	3.68	4.04	7.72
T_9(TIBA15 ppm)	22.71	24.30	10.98	3.85	4.47	8.32
T_{10}(TIBA 20 ppm)	22.51	24.32	11.18	3.96	4.50	8.46
S.Em. ±	0.75	0.84	0.12	0.17	0.19	0.23
C.D. at 5 %	2.18	2.43	NS	NS	NS	NS

Conclusion

In view of the results obtained from present investigation, it could be concluded that the better growth, early flowering, minimum sex ratio, highest fruit yield and superior quality could be achieved by the spray of TIBA 20 ppm at 2-4 leaf stages in watermelon cv. 'Durgapura Lal (RW-177-3)' under the North Gujarat Agro-climatic conditions.

Conflict of Interest: None declared

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