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INFLUENCE OF PLANT GROWTH REGULATORS ON GROWTH AND FLOWERING PARAMETERS OF WATERMELON (*Citrullus lanatus* (Thunb) Mansf.) CV. SUGAR BABY

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Watermelon (*Citrullus lanatus* (Thunb) Mansf.) is believed to be the native of Africa (Harry, 2015). Watermelon has high nutritive value, is rich in vitamin 'C', low in sugar and calories because of high per cent of water (Bose *et al*., 2002). Watermelon is used mainly as a dessert and rind is used to some extent in making preserves and pickles. The raw fruits can be used for pickling and candy making. The fruits are very seldom cooked as vegetable when immature. In India, watermelon is grown in about 1.16 lakh hectare areas with the production of 3.16 million MT (Anonymous, 2019-20).

Plant growth regulators other than nutrients usually are organic compounds. They are either natural or synthetic compounds and applied directly on plant to alter its life processes or structure in some beneficial ways so as to enhance yield and improve quality (Nickell, 1982). Exogenous application of plant growth regulators can alter the sequence of male and female flowers, if applied at 2nd to 4th leaf stages, the critical stage at which suppression or promotion of either sex is possible. Plant growth regulators *viz*., NAA, GA_3, TIBA, MH, and Ethrel have been reported to play significant role in plant developmental process and thus modulate plant replies (Rafeekhar *et al*., 2001). The present investigation was taken to evaluate the influence of GA_3, NAA, Ethrel and calcium on growth and flowering parameters of watermelon.

The experiment, laid out in randomized block design with three replications, was carried out at College farm, College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Jagudan, Dist. Mehsana, Gujarat, India during summer season, 2019. Fourteen treatments were evaluated in the study *viz*., T_1: Control; T_2: Water spray; T_3: GA_3 20 ppm; T_4: GA_3 30 ppm; T_5: GA_3 40 ppm; T_6: NAA 40 ppm; T_7: NAA 50 ppm; T_8: NAA 60 ppm; T_9 : Ethrel 50 ppm; T_{10}: Ethrel 100 ppm; T_{11}: Ethrel 150 ppm; T_{12}: Ca 10 ppm; T_{13}: Ca 20 ppm; T_{14}: Ca 30 ppm. The seeds of monoecious watermelon cv. Sugar Baby were sown at spacing of 1.5 m × 1 m. The farmyard manure (FYM) at the rate of 20 tons per hectare and recommended dose of fertilizer 100: 50: 50 kg/ha NPK were applied. Half quantity of nitrogen in the form of urea and whole quantity of P_2O_5 and K_2O as basal dose were given in the form of single superphoshphate (SSP) and muriate of potash (MOP), respectively and remaining half dose of nitrogen was applied at 30 days after sowing. Standard cultural operations were followed during the entire course of investigation. Plant growth regulators were applied (spray) as per the treatment twice at 2nd and 4th true leaf stages during morning hours till both sides of leaves completely wet. The observations were recorded on growth and flowering traits from five randomly tagged plants. All the data were statistically analyzed as per the standard methods suggested by Panse and Sukhatme (1985). In order to get an idea about the climatic conditions and effects on crop growth and flowering, an average weekly data on maximum and minimum temperature, relative humidity, wind velocity and rainfall pertaining to the period of present investigation was obtained as recorded at the meteorological observatory located at the Seed Spices Research Station, Sardarkrushinagar Dantiwada Agricultural University, Jagudan as given in Fig. 1.

Growth parameters

Results presented in Table 1 indicated the length of main creeper at 45, 60 DAS and at harvest and number of branches per vine were found significant with the application treatment T_5 (GA_3 40 ppm). The maximum length of main creeper at 45 DAS was recorded with treatment T_5 (GA_3 40 ppm) *i.e.* 124.10 cm, which was statistically at par with treatment T_4 (GA_3 30 ppm), T_3 (GA_3 20 ppm), T_{11} (Ethrel 150 ppm) and T_{10} (Ethrel 100 ppm) *i.e.* 114.12 cm, 112.00 cm, 111.90 cm and 107.62 cm, respectively. The maximum length of main creeper at 60 DAS was recorded with treatment T_5 (GA_3 40 ppm) *i.e.* 200.77 cm, which was statistically at par with treatment T_4 (GA_3 30 ppm), T_3 (GA_3 20 ppm), T_{11} (Ethrel 150 ppm), T_{10} (Ethrel 100 ppm) and T_9 (Ethrel 50 ppm) *i.e.* 194.57 cm, 191.97 cm, 191.83 cm, 182.00 cm and 179.20 cm, respectively. The maximum length of main creeper at harvest was also recorded in treatment T_5 (GA_3 40 ppm) *i.e.* 300.70 cm, which was statistically

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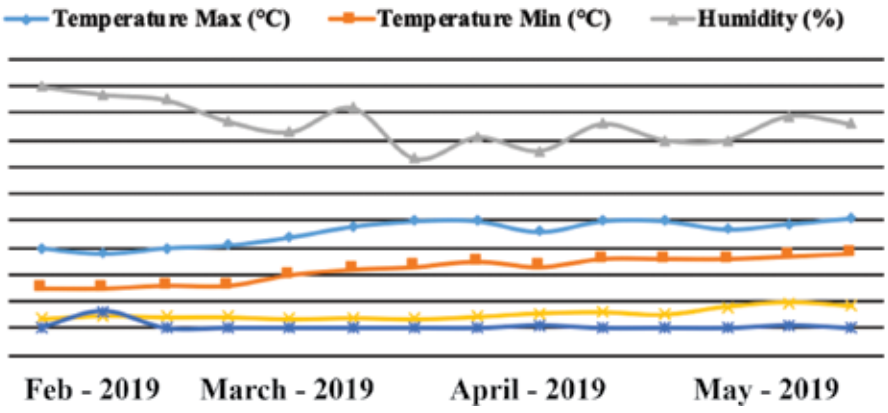

Fig.1. Mean weekly weather parameters recorded during experimental period

at par with treatment T_{11} (Ethrel 150 ppm), T_4 (GA_3 30 ppm), T_3 (GA_3 20 ppm) and T_{10} (Ethrel 100 ppm) *i.e.* 292.63 cm, 291.70 cm, 284.53 cm and 283.13 cm, respectively. The beneficial effect of GA_3 at particular concentrations could be attributed to stimulatory action of GA_3 resulting in increased vine length (Hilli *et al.,* 2010). These results are in close accordance with those reported by Dixit *et al.* (2001). The maximum number of branches per vine was observed with the treatment T_5 (GA_3 40 ppm) *i.e.* 6.30 which was statistically at par with treatment T_4 (GA_3 30 ppm), T_8 (NAA 60 ppm), T_7 (NAA 50 ppm) and T_3 (GA_3 20 ppm) *i.e.* 6.03, 6.00, 5.83 and 5.67, respectively. Results are in accordance with findings of Sinojiya *et al*. (2015) who observed maximum number of branches per vine (16.67) with the application of GA_3 20 ppm in muskmelon cv. Rasmadhuri.

Flowering traits

The changes in flowering parameters of watermelon affected by various levels of GA_3, NAA, Ethrel and calcium are presented in Table 2. The minimum days taken to first male flower appearance was recorded with treatment T_1 (GA_3 40 ppm) *i.e.* 43.43, which was statistically at par with treatment T_4 (GA_3 30 ppm) and T_3 (GA_3 20 ppm) *i.e.* 45.13 and 46.53, respectively. Though, the minimum days taken to first female flower appearance was recorded with treatment T_{11} (Ethrel

Table 1. Influence of GA_3, NAA, Ethrel and calcium on length of main creeper and number of branches per vine

Treatment	Treatment details	Length of main creeper			Number of branches per vine
		At 45 DAS	At 60 DAS	At harvest	
T_1	Control	88.93	168.93	243.43	3.53
T_2	Water Spray	89.43	169.50	242.53	3.60
T_3	$GA_3$20 ppm	112.00	191.97	284.53	5.67
T_4	GA_3 30 ppm	114.57	194.57	291.70	6.03
T_5	GA_3 40 ppm	124.10	200.77	300.70	6.30
T_6	NAA 40 ppm	90.53	165.90	269.23	5.30
T_7	NAA 50 ppm	94.10	167.73	271.27	5.83
T_8	NAA 60 ppm	100.17	171.17	273.83	6.00
T_9	Ethrel 50 ppm	104.00	179.20	279.77	4.73
T_{10}	Ethrel 100 ppm	107.62	182.00	283.13	4.80
T_{11}	Ethrel 150 ppm	111.90	191.83	292.63	5.07
T_{12}	Ca 10 ppm	89.67	169.60	267.83	3.93
T_{13}	Ca 20 ppm	89.77	170.83	268.00	4.10
T_{14}	Ca 30 ppm	91.00	170.97	264.87	4.13
S.Em. ±		6.91	7.87	7.19	0.26
C.D. at 5 %		20.08	22.86	20.90	0.74
C.V. %		11.90	7.65	4.55	8.99

Table 2. Influence of GA_3, NAA, Ethrel and calcium on flowering parameters of watermelon cv. 'Sugar Baby'

Treatment	Treatment details	Days taken to first male flower appearance	Days taken to first female flower appearance	Male flowers	Female flowers	Sex ratio (M/ F)
T_1	Control	50.53	60.77	43.03	3.97	10.85
T_2	Water Spray	51.43	60.43	43.33	4.13	10.48
T_3	$GA_3$20 ppm	46.53	60.73	49.50	5.10	9.71
T_4	GA_3 30 ppm	45.13	58.67	53.33	5.63	9.47
T_5	GA_3 40 ppm	43.43	57.60	55.50	5.97	9.30
T_6	NAA 40 ppm	51.87	60.57	46.13	4.70	9.82
T_7	NAA 50 ppm	50.50	59.63	49.40	5.13	9.62
T_8	NAA 60 ppm	49.70	59.03	54.17	5.80	9.34
T_9	Ethrel 50 ppm	48.87	56.70	47.07	5.97	7.89
T_{10}	Ethrel 100 ppm	48.20	55.87	50.17	6.40	7.84
T_{11}	Ethrel 150 ppm	47.40	53.00	50.57	6.63	7.62
T_{12}	Ca 10 ppm	52.17	60.60	43.33	4.60	9.42
T_{13}	Ca 20 ppm	51.97	60.57	45.00	4.83	9.31
T_{14}	Ca 30 ppm	50.07	59.03	45.10	5.00	9.02
S.Em. ±		1.33	1.56	1.65	0.31	0.28
C.D. at 5 %		3.86	4.55	4.80	0.91	0.83
C.V. %		4.68	4.61	5.92	10.30	5.32

150 ppm) *i.e*. 53.00, which was statistically at par with treatment T_{10} (Ethrel 100 ppm) and T_9 (Ethrel 50 ppm) *i.e.* 55.87 and 56.70, respectively. Minimum number of male flowers per vine *i.e*. 43.03 was observed in T_1, which was statistically at par with treatment T_2 (water spray), T_6 (NAA 40 ppm), T_9 (Ethrel 50 ppm), T_{12} (Ca 10 ppm), T_{13} (Ca 20 ppm) and T_{14} (Ca 30 ppm). However, maximum number of female flowers per vine was observed in treatment T_{11} (Ethrel 150 ppm) *i.e.* 6.63, which was statistically at par with treatments T_{10} (Ethrel 100 ppm), T_9 (Ethrel 50 ppm), T_5 (GA_3 40 ppm) and T_8 (NAA 60 ppm) *i.e.* 6.40 and 5.97, respectively. The lowest sex ratio (male: female flowers) was recorded with treatment T_{11} (Ethrel 150 ppm) *i.e.*7.62, which was statistically at par with treatment T_{10} (Ethrel 100 ppm) and T_9 (Ethrel 50 ppm) *i.e.* 7.84 and 7.89. Girek *et al.* (2013) reported that ethrel increased the number of perfect or pistillate flowers per plant, reduced the number of male flowers per plant and reduced the sex ratio in melon (*Cucumis melo* L.). The present findings were in close agreement with the findings of Thappa *et al.* (2011) in cucumber and Chaurasiya *et al*. (2016) in muskmelon and they observed ethrel 150 ppm proved one of the best treatments in respect of the highest number of female flower which directly enhanced yield. Patel *et al*. (2017) also reported similar effect of PGR in bottle gourd. Ansari and Chowdhary (2018) on effect of boron and PGR in bottle gourd and Aishwarya *et al*. (2019) revealed that the application of ethrel @ 200 ppm at 2nd and 4th leaf stages resulted in earliness to first pistillate flower appearance (34.30), delayed male flower appearance (32.78), highest female flowers per vine (41.40), minimum number of male flowers (253.46) and narrow sex ratio in bitter gourd cv. VK 1 Priya.

It was concluded that the foliar application of GA_3 40 ppm twice at 2nd and 4th true leaf stage was found superior for growth and flowering traits like; length of main creeper, number of branches per vine, days taken to first male flower appearance and number of male flowers per vine. The application of Ethrel 150 ppm was found better for days taken to first female flower appearance, number of female flowers per vine and lowest sex ratio (M/F). Calcium and NAA treatments have poor effects on growth and flowering traits as compared to the best treatment.

Authors' contribution

Conceptualization of research work and designing of experiments (CT, JRV, SKA, MK, NRS); Execution of field/lab experiments and data collection (CT, JRV, SKA, MK, NRS); Analysis of data and interpretation (CT, JRV, SKA, MK, NRS); Preparation of manuscript (CT, JRV, SKA, MK, NRS)

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