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STUDIES ON THE INFLUENCE OF GROWTH REGULATORS AND MICRONUTRIENTS ON GROWTH AND YIELD OF CUSTARD APPLE (*Annona squamosa* L.) *CV*. BALANAGAR

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ABSTRACT

A field experiment was conducted on "Studies on the influence of growth regulators and micronutrients on growth, yield and quality of custard apple (*Annona squamosa* L.) *cv*. Balanagar" at Division of Fruit Science, MHREC, University of Horticultural Sciences, Bagalkot during 2022-23. The experiment was consisting of twelve treatments with three replications and performed under Randomized Completely Block Design (RCBD). The treatments were imposed at flowering, fruit setting and fruit development stage. The results revealed that, the significantly the maximum plant height (2.57, 3.07, 3.32 and 3.75 m) and the maximum canopy volume (1.95, 2.24, 2.39 and 2.54 m^3) at 30, 60, 90 and 120 days after treatment imposition (DATI), respectively was recorded in treatment (T_3), which comprises 75 ppm GA_3. As per the yield and yield attributing parameters are concerned, the treatment T_8 (GA_3 75 ppm + $ZnSO_4$ 0.5 %+ $FeSO_4$ 0.5 % + Boric acid 0.3 %) recorded the minimum number of days taken for flowering (30.33), seed weight (16.00 g) per fruit, whereas treatment T_3 recorded the maximum fruit set (14.96 %) percentage and T_8 recorded the maximum number of flowers (561.60) per plant, number of fruits (82.39) per plant, fruit weight (187.66 g), fruit length (7.30 cm), fruit diameter (8.70 cm), volume of fruit (195.00 ml), fruit yield (20.77 kg/plant and 10.26 t/ha). From the research, it is concluded that, the custard apple plants treated with GA_3 75 ppm in Treatment T_3 showed more influence on growth parameters and treatment T_8 with GA_3 75 ppm + $ZnSO_4$ 0.5 %+ $FeSO_4$ 0.5 % + Boric acid 0.3 % exhibited the highest influence on yield and quality aspects of fruit.

***Keywords*:** Growth Regulators, Micronutrients, Growth and Yield,Custard Apple (*Annona squamosa* L.)

Introduction

Annonaceae family has 120 genera and more than 2000 species are existing on the earth, among them, Annona being the most economically important one which includes *Annona squamosa*, *A. reticulata*, *A. cherimoya*, *A. atemoya*, *A. muricata* and *A. glabra*. While, *A. squamosa* commonly called as custard apple, it is originated from tropical South American but commercially produced in Africa, Australia, China, India, Mexico, USA, Philippines and Thailand. It is a deciduous fruit tree of the Annonaceae family that grows well in subtropics. It had a wide range of adaptation to soil and climatic conditions and occurrence of pest and diseases are very less due the presence of insecticidal properties in leaves. They have become naturalized in many tropical and subtropical

sections of the world, with a huge potential for additional growth due to their hardiness and resistance to animal damage Mahorkar *et al.* (2018).

Annona squamosa L. also known as "custard apple," it is a tropical, endemic species of the West Indies, South and Central America, Ecuador, Peru, Brazil, India, Mexico, Bahamas, Bermuda and Egypt. Custard apple is India's most significant arid fruit crop among annonaceous fruits. It is classified as a semi-wild fruit. In India, as reported by the Indian Council of Agricultural Research (ICAR), *Annona squamosa* is extensively cultivated in various states such as Maharashtra, Gujarat, Madhya Pradesh, Chhattisgarh, Assam, Uttar Pradesh, Bihar, Rajasthan, Andhra Pradesh and Tamil Nadu with a total area of 41,000 ha, with an annual production of 387.26 MT (Anon, 2021). Maharashtra stands first in production of custard apple with a total production of 120.88MT (Anon, 2021). In Karnataka, it is grown in an area of 1800 ha with the production of 13,400 tonnes and productivity of 7.4 tonnes per hectare (Anon, 2021).

As it is an arid fruit crop, so it requires a dry atmosphere with mild winters to thrive and it can grow up to 100 m above mean sea level. It is the most frequently grown fruit in India and probably in the world tropical or subtropical region. It is also known as 'sugar apple', 'sweetsop' and is known as 'Sharifa' in Northern India and 'Sitaphal' in Southern India. It's a deciduous, tall, woody shrub or small tree with irregularly spreading branches that grows to around 5 to 6 meters in height. Their lanceolate and acuminate leaves are alternately double-ranked. The greenish yellow blooms appear in bunches or on their own in an additional axillary position.

Custard apple flowers possess a floral chamber with three fleshy white or green petals enclosing numerous reproductive organs. The flowers are hermaphrodite and protogynous, with the female phase maturing earlier and remaining receptive for up to 24 hours. Flowering occurs on both old and new growth from March–April to July–August, peaking in April and May. However, fruit set is mainly observed during the rainy season rather than throughout the entire flowering period (Ghosh. 2014).

Custard apple is a highly delicious and nutritionally important fruit, characterized by loosely arranged carpels forming a tuberculated surface and a soft, sweet, mildly acidic pulp. It is widely consumed fresh as a dessert and also used in products like ice cream, confectionery, jams and jellies. Beyond its culinary value, various parts of the plant immature fruits, seeds, leaves and roots have significant medicinal uses in Ayurveda (Pareekh and Sharma, 1993). Additionally, seeds are rich in nitrogen and used as manure, while plant extracts contain bioactive compounds with therapeutic properties such as anti-tumor, antioxidant and wound-healing effects (Ghosh. 2014).

Sugar apple contains a lot of vitamin C, dietary fibre, vitamin B_6, magnesium, potassium and a little amount of vitamin B_2, as well as some complex carbohydrates. Just 100 g of fruit flesh provide almost 110 mg of the required daily intake of vitamin C. With a score of 104, they are regarded as a reliable source of energy (Kcal). In 100 g of fruit pulp, there are 20.82 g of carbohydrates, 1.89 g of protein, 0.9 g of minerals, 1.41 g of fibre, 17 mg of calcium, 54 mg of phosphorus, 0.30 mg of iron and 37 mg of vitamins (Ghosh. 2014).

Low productivity due to poor fruit set and poor cross pollination by insect (due to insecticidal property of leaves and lack of fragrance, colour and nectar in flowers) in sugar apple is the major constraints in expansion of its commercial cultivation (Hayes, 1957, George and Nissen, 2002). Custard apple plant produces enough blossoms to provide a good harvest but the poor fruit set results in a reduced yield. Under natural circumstances, just one to eight per cent of fruit set has been documented (Ahmed, 1936, Venkataratnam, 1963, Thakur and Singh, 1965, Kumar *et al*, 1977 and George and Nissen, 1988). The fruit set in custard apple, which has been linked to both external and internal factors such as high and low humidity during flowering, soil moisture stress and competition between vegetative and floral growth, hypogyny, dichogamy, poor pollen germination and a lack of insect pollinators. Soil moisture stress also reduces flowering and fruit set, particularly at high temperature (28°C). Hand-pollination of flowers, even under high vapour pressure deficient conditions resulted in higher fruit set (>20 %) (Ghosh, 2014).

Cultural practices such as overhead misting, windbreaks and proper irrigation management can improve custard apple productivity (George and Nissen, 1988). Thakur and Singh (1965) found that high temperature and according to Hopping (1983), low relative humidity, especially during May–June, reduce pollen viability and stigma receptivity, leading to poor fruit set. As a result, fruit set mainly occurs during the rainy season when environmental conditions improve. In contrast, southern India, with relatively higher humidity and lower temperatures, shows earlier fruit set compared to northern regions (Hayes, 1957; Kumar *et al.*, 1977).

Another important constraint in production of custard apple is presence of more number of seeds which makes it unfavourable for its consumption. Apart from this, higher percentage of flower drop, poor fruit setting and fruit retention are all significant issues. Therefore, it is essential to find out the exact reasons and reliable solutions to address the above issues. Plant growth regulators and micronutrients are now widely used in the development of a variety of fruit crops. In crop production, growth regulators and micronutrients have become significant for improving flowering, fruit set, reducing fruit drop, fruit size, yield and fruit quality. Plant growth regulators and micronutrients such as GA_3 (gibberellic acid), NAA (naphthalene acetic acid), Ethrel, $ZnSO_4$, $FeSO_4$ and boric acid are thus required to boost custard apple output both numerically and qualitatively (Mahorkar *et al*., 2020; Makhmale and Delvadia, 2015)

Application of plant growth regulators and micronutrients such as NAA, Ethrel, GA_3, $ZnSO_4$, $FeSO_4$ and boric acid in custard apple has also yielded promising results in terms of fruit set, fruit retention and fruit size. The plant growth regulators are very effective at very low concentration and bring lot of physiological changes in the growth and development of the plant. NAA increases the number of flowers in plants, increases the fruit set percentage, GA_3 helps in cell elongation, growth of plants, increase in fruit weight, ethrel known to increase flower bud development, uniform fruit ripening, color development, micronutrients such as zinc maintain the auxin concentration in plants through synthesis of tryptophan and RNA Iron helps in synthesis of chlorophyll and nucleic acids, energy relation. While, boron induces carbohydrate metabolism, stomatal regulation, it also influences in reproduction and pollen grain germination (Suman *et al*., 2017)

Presently, growth regulators and micronutrients are given considerable importance for their value in regulating the various growth and development process in plants (Thorat *et al.*, 2018). Normally, in custard apple peak flowering will occur during May- June and harvesting will be done in September–October months, this kind of situations creates a glut in the market as most of the orchards come to harvest at a time. Otherwise, there is huge demand for custard apple if it is produced by early flowering *i.e.*, during February-March.

Therefore, the present study entitled "Studies on influence of growth regulators and micronutrients on growth, yield and quality of custard apple (*Annona squamosa* L.) *cv.* Balanagar was planned for early flowering to catch the early market value and also to avoid the glut in the market with the following objectives:

1. To study the influence of growth regulators and micronutrients on growth parameters of custard apple *cv.* Balanagar.
2. To study the influence of growth regulators and micronutrients on yield parameters of custard apple *cv.* Balanagar

Material and Methods

The present investigation entitled "Studies on the influence of growth regulators and micronutrients on growth and yield of custard apple *(Annona squamosa* L.*) cv.* Balanagar" was carried out during 2022-2023 at Main Horticultural Research and Extension Centre (MHREC), University of Horticultural Sciences, Bagalkot. It comes under Northern dry zone (Zone-3) of Karnataka located at 16^0 10' North latitude, 75^0 42' East longitude and an altitude of 542 m above mean sea level. The grafted custard plants are twelve-year-old was selected for the experiment. The spacing followed between the plants and rows were 15 feet. The experiment was conducted in Randomized Complete Block Design (RCBD) with twelve treatments and three replications. Five plants in each replication were selected randomly for recording the observations.

Treatment Details

T_1	Control
T_2	GA_3 50 ppm
T_3	GA_3 75 ppm
T_4	NAA 75 ppm
T_5	NAA 100 ppm
T_6	Ethrel 100 ppm
T_7	GA_3 50 ppm+ $ZnSO_4$ 0.5 %+ $FeSO_4$ 0.5 % + Boric acid 0.3 %
T_8	GA_3 75 ppm + $ZnSO_4$ 0.5 %+ $FeSO_4$ 0.5 % + Boric acid 0.3 %
T_9	NAA 75 ppm+ $ZnSO_4$ 0.5 %+ $FeSO_4$ 0.5 % + Boric acid 0.3 %
T_{10}	NAA 100 ppm+ $ZnSO_4$ 0.5 %+ $FeSO_4$ 0.5 % + Boric acid 0.3 %
T_{11}	Ethrel 100 ppm + $ZnSO_4$ 0.5 %+ $FeSO_4$ 0.5 % + Boric acid 0.3 %
T_{12}	NAA 50 ppm + Ethrel 100 ppm + $ZnSO_3$ 0.5 %+ $FeSO_4$ 0.5 % + Boric acid 0.3 %

(GA_3 – Gibberellic acid, NAA- Napthalene acetic acid, $ZnSO_4$ – Zinc sulphate, $FeSO_4$ –Ferrous sulphate, ppm- parts per million)

Time of treatment imposition

Growth regulators

GA_3 + NAA + Ethrel: Two stage of application

- At flowering (One month after pruning may be during February)

- At fruit setting stage (one month after first spray)

Micronutrients:

$ZnSO_4$ + $FeSO_4$+Boric acid: Three stage of application

- At flowering
- At fruit setting (after few days of fruit set)
- At fruit development stage

Pruning of terminal shoots to ensure new growth and also removal of dried, crisscrossed, basal shoots and diseased branches were done by using secateurs and also, defoliation and removal of last season fruits remain on the plant itself were done manually and plants were irrigated regularly and it was stopped 15-20 days before harvest. Application of manures and fertilizer (25 tonnes of FYM and 123 kg: 62 kg: 62 kg N: P: K per hectare or 250:125:125 g of NPK/plant) was done for all the experimental plants during the initial stage of the experiment as per the package of practice recommended by the University of Horticultural Sciences Bagalkot.

Details of the observations recorded

Growth parameters like plant height was measured using scale, canopy volume by formula given below, number of primary shoots were counted manually, Chlorophyll content by SPAD-502. While yield parameters like Number of days taken for flowering, Number of flowers per plant, Number of fruits per plant and stone fruits were counted manually, fruit set was calculated by below formula, The average fruit weight was calculated by taking the mean weight of five fruits from every five plants of each replication and the values were expressed in g and kg. fruit diameter and fruit length was measured with the help of vernier calipers, volume of the fruits was recorded by water displacement method. The specific gravity of a fruit was measured by dividing density of fruit by density of water and the yield per hectare was calculated by multiplying the yield per tree (kg) by total number of plants per hectare and the values were expressed in tonnes.

$$\text{Canopy volume } (m^3) = \frac{\text{Plant spread (N-S)} \times \text{Plant spread} \times (\text{E-W}) \times \text{Plant height}}{4}$$

$$\text{Fruit set (\%)} = \frac{\text{Total number of fruits}}{\text{Total number of flowers per tree}} \times 100$$

Table 1: Plant height at different growth stages as influenced by growth regulators and micronutrients on custard apple *cv.* Balanagar.

Treatment	Plant height (m)			
	30 DATI	60 DATI	90 DATI	120 DATI
T_1	2.22	2.72	2.97	3.40
T_2	2.27	2.77	3.02	3.45
T_3	2.57	3.07	3.32	3.75
T_4	2.30	2.86	3.11	3.54
T_5	2.36	2.83	3.08	3.51
T_6	2.43	2.93	3.18	3.66
T_7	2.26	2.76	3.01	3.44
T_8	2.56	3.06	3.31	3.74
T_9	2.35	2.85	3.10	3.53
T_{10}	2.48	2.98	3.23	3.66
T_{11}	2.33	2.83	3.08	3.51
T_{12}	2.30	2.86	3.11	3.54
S. Em ±	**0.006**	**0.006**	**0.006**	**0.06**
CD at 5 %	**0.019**	**0.019**	**0.019**	**0.019**

Table 2: Canopy volume at different growth stages as influenced by growth regulators and micronutrients on custard apple *cv.* Balanagar

Treatment	Canopy volume (m^3)			
	30 DATI	60 DATI	90 DATI	120 DATI
T_1	1.37	1.51	1.66	1.80
T_2	1.69	1.87	2.02	2.16
T_3	1.95	2.24	2.39	2.54
T_4	1.41	1.58	1.73	1.88
T_5	1.40	1.58	1.72	1.87
T_6	1.50	1.67	1.82	1.97
T_7	1.23	1.40	1.55	1.70
T_8	1.85	2.13	2.32	2.35
T_9	1.60	1.78	1.93	2.07
T_{10}	1.85	2.12	2.31	2.32
T_{11}	1.65	1.83	1.97	2.12
T_{12}	1.52	1.69	1.84	1.99
S. Em ±	**0.04**	**0.05**	**0.06**	**0.04**
CD at 5 %	**0.12**	**0.15**	**0.17**	**0.13**

Table 3: Number of primary shoots at different growth stages as influenced by growth regulators and micronutrients on custard apple *cv.* Balanagar

Treatment	Number of primary shoots per plant			
	30 DATI	60 DATI	90 DATI	120 DATI
T_1	2.22	2.22	2.22	2.22
T_2	2.27	2.27	2.27	2.27
T_3	3.05	3.05	3.05	3.05
T_4	2.44	2.44	2.44	2.44
T_5	2.78	2.78	2.78	2.78
T_6	2.45	2.45	2.45	2.45
T_7	2.88	2.88	2.88	2.88
T_8	2.11	2.11	2.11	2.11
T_9	2.33	2.33	2.33	2.33
T_{10}	2.88	2.88	2.88	2.88
T_{11}	2.38	2.38	2.38	2.38
T_{12}	2.66	2.66	2.66	2.66
S. Em ±	**0.2**	**0.2**	**0.2**	**0.2**
CD at 5 %	**NS**	**NS**	**NS**	**NS**

Table 4: Chlorophyll content (SPAD values) at different growth stages as influenced by growth regulators and micronutrients on custard apple *cv.* Balanagar

Treatment	Chlorophyll content (SPAD units)			
	30 DATI	60 DATI	90 DATI	120 DATI
T_1	31.44	31.57	32.39	35.14
T_2	35.42	36.34	36.89	36.84
T_3	36.29	35.32	35.06	35.19
T_4	33.86	33.68	33.19	34.43
T_5	34.72	34.76	34.32	33.53
T_6	34.17	33.78	34.24	34.96
T_7	34.48	34.90	35.85	36.68
T_8	31.94	31.98	32.70	32.96
T_9	34.31	35.56	36.77	37.39
T_{10}	35.09	35.43	35.33	36.13
T_{11}	34.10	33.54	32.71	36.96
T_{12}	33.56	33.26	33.33	35.35
S. Em ±	**1.13**	**0.98**	**1.07**	**1.28**
CD at 5 %	**NS**	**NS**	**NS**	**NS**

Table 5: Number of days taken for flowering after pruning and number of flowers per plant of custard apple *cv.* Balanagar as influenced by growth regulators and micronutrients

Treatment	No. of days taken for flowering (after pruning)	No. of flowers per plant
T_1	35.33	437.33
T_2	34.00	521.33
T_3	31.66	541.66
T_4	32.00	522.66
T_5	34.33	516.66
T_6	33.66	493.00
T_7	34.66	514.00
T_8	30.33	561.60
T_9	34.33	519.33
T_{10}	32.33	558.33
T_{11}	33.66	494.66
T_{12}	32.00	509.00
S. Em ±	**0.80**	**8.60**
CD at 5 %	**2.37**	**25.24**

Table 6: Number of fruits per plant and fruit set percentage in custard apple *cv.* Balanagar as influenced by growth regulators and micronutrients

Treatment	Number of fruits/plant	Fruit set (%)
T_1	48.70	11.14
T_2	75.70	14.52
T_3	81.03	14.96
T_4	67.03	12.85
T_5	69.72	13.50
T_6	57.03	11.57
T_7	71.03	13.84
T_8	82.39	14.70
T_9	61.36	11.82
T_{10}	80.37	14.39
T_{11}	53.03	10.73
T_{12}	51.36	10.09
S. Em ±	**0.72**	**0.24**
CD at 5 %	**2.12**	**0.70**

Table 7: Fruit weight, fruit diameter, fruit length, seed weight and specific gravity in custard apple *cv.* Balanagar as influenced by growth regulators and micronutrients

Treatment	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Seed weight/ fruit (g)	Volume of fruit (ml)	Specific gravity (g/cc)
T_1	137.67	4.60	6.73	25.00	101.66	1.36
T_2	178.00	5.83	7.56	21.30	151.66	1.17
T_3	183.00	7.13	8.60	17.30	193.33	0.94
T_4	173.00	5.70	7.26	20.30	145.00	1.19
T_5	176.66	5.90	7.66	19.00	146.66	1.21
T_6	150.00	5.60	7.53	22.00	153.66	1.00
T_7	180.66	5.16	7.46	19.60	156.66	1.22
T_8	187.66	7.30	8.70	16.00	195.00	0.96
T_9	173.33	7.20	7.46	20.30	154.66	1.13
T_{10}	181.33	7.23	8.43	18.30	191.66	0.94
T_{11}	153.33	6.73	7.56	21.00	154.66	1.00
T_{12}	178.33	6.63	8.50	24.30	158.66	1.13
S. Em ±	**2.77**	**0.27**	**0.30**	**1.17**	**11.44**	**0.09**
CD at 5 %	**8.13**	**0.79**	**0.89**	**3.46**	**33.56**	**NS**

Table 8: Fruit yield (kg/plant and t/ha) and stone fruits per plant in custard apple *cv.* Balanagar as influenced by growth regulators and micronutrients

Treatment	Fruit yield (kg/plant)	Fruit yield (t/ha)	Stone fruits/plant
T_1	11.43	5.64	3.60
T_2	15.73	7.77	3.00
T_3	19.80	9.78	1.60
T_4	15.67	7.73	2.00
T_5	15.77	7.78	3.00
T_6	16.73	8.26	2.00
T_7	16.50	8.15	3.30
T_8	20.77	10.26	1.30
T_9	16.03	7.92	1.60
T_{10}	18.03	8.90	1.60
T_{11}	14.97	7.39	3.00
T_{12}	15.72	7.76	2.00
S. Em ±	**1.33**	**0.65**	**0.58**
CD at 5 %	**3.90**	**1.93**	**NS**

Results

The data showed significant difference with respect to different vegetative parameters such as plant height and canopy volume at 30,60,90 and 120 days after imposition of the treatment. Among the treatments, the highest plant height (table 1) and canopy volume (table 2) as recorded in treatment T_3

(GA_3 75ppm) which was at par with T_8 which comprises GA_3 75ppm + $ZnSO_4$ 0.5%+ $FeSO_4$ 0.5% + boric acid 0.3%. However, the lowest plant height, canopy volume was recorded in T_1 (control). However, the influence of trunk girth, number of primary shoots (Table 3) and chlorophyll content (Table 4) of leaves was found non-significant.

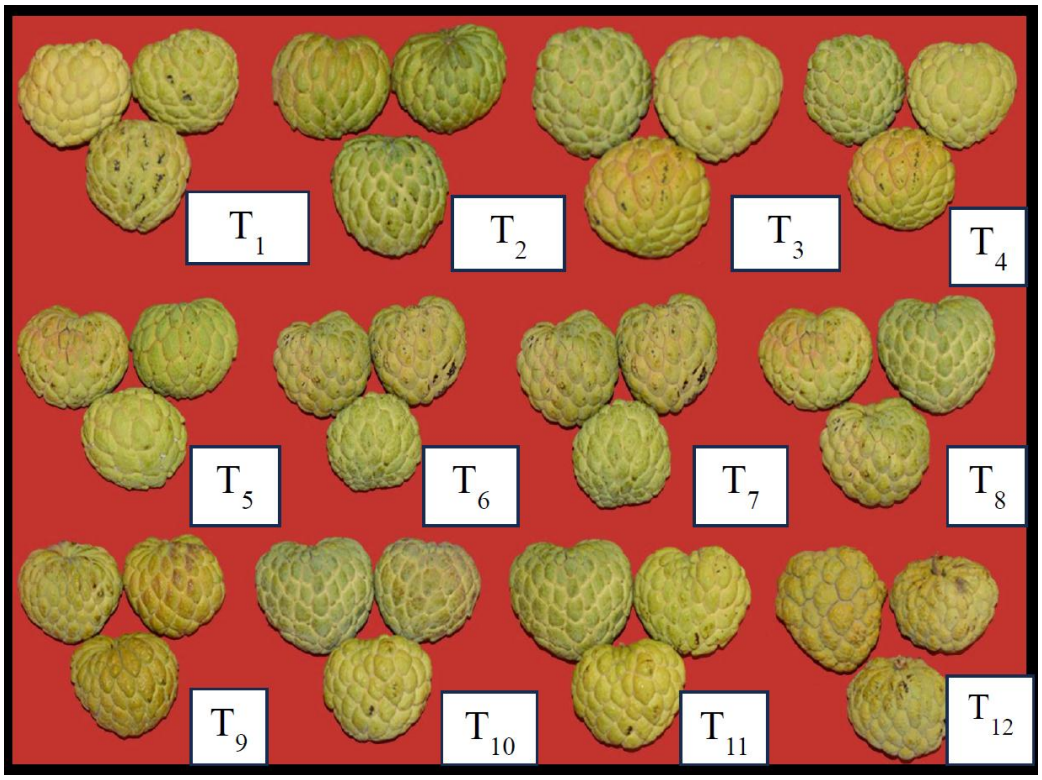

Fig. 1: Harvested fruits of different treatments as influenced by the application of growth regulators and micronutrients on custard apple cv. Balanagar.

Regarding yield parameters, the minimum number of days taken for flowering after the pruning was recorded in T_8 which was on par with T_3, T_4, T_{12} and T_{10}. Whereas, the maximum number of days for flowering was recorded in T_1. The maximum number of flowers, number of fruits per plant, fruit weight, fruit length, fruit diameter (figure 1), minimum seed weight, fruit volume (table 7) and fruit yield was recorded highest in T_8 and the minimum was recorded in T_1 respectively. While, highest fruit set was noted in T_3 (14.96%) which was on par with T_8, T_2 and T_{10}. Whereas, the lowest fruit set was recorded in T_{12} which is at par with T_{11}.

Discussion

The investigation into custard apple cv. Balanagar revealed that vegetative parameters like plant height and canopy volume were most significantly improved by treatment T3 (GA3 75ppm), as gibberellic acid promotes rapid cell elongation and division in the meristematic zone while increasing cell wall plasticity through starch hydrolysis (Yadav *et al*. 2017). The improvement of the length of plant and canopy volume was due to both increased in number and length of cells (Prajapati *et al*., 2016) in custard apple. The results are in conformity with Phawa *et al*. (2017) in pomegranate, Saima *et al*. (2014) in strawberry. For yield-related parameters, treatment T8 (GA3 75ppm + ZnSO4 0.5% + FeSO4 0.5% + Boric acid 0.3%) was superior, recording the minimum days to flowering and the maximum number of flowers (table 5) and fruit

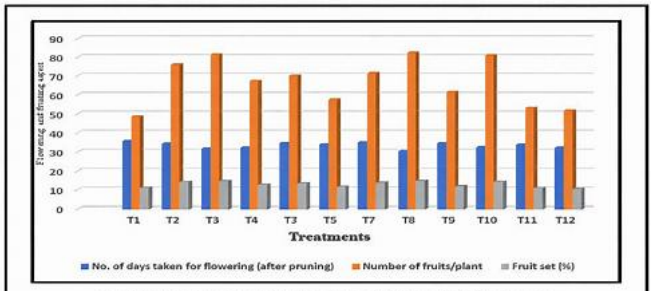

Fig. 2. Number of days taken for flowering, number of fruits/ plant and fruit set percatge.

T_1: Control; T_2:GA_3 50ppm, T_3: GA_3 75ppm, T_3: NAA 75ppm, T_5: NAB 100ppm,T_6:Ethrel 100ppm, T_7: GA_3 50ppm+ $ZnSO_4$ 0.5%+ $FeSO_4$ 0.5% + Boric acid 0.3%, T_8: GA_3 75ppm + $ZnSO_4$ 0.5%+ $FeSO_4$ 0.5% + Boric acid 0.3% , T_9: NAA 75ppm+ $ZnSO_4$ 0.5%+ $FeSO_4$ 0.5% + Boric acid 0.3%, T_9: NAA 100ppm + $ZnSO_4$ 0.5%+ $FeSO_4$ 0.5% + Boric acid 0.3%, T_{11}:Ethrel 100ppm + $ZnSO_4$ 0.5%+ $FeSO_4$ 0.5% + Boric acid 0.3%, T_{12}: NAA 50ppm + $ZnSO_4$ 0.5%+ $FeSO_4$ 0.5% + Boric acid 0.3%+Boric acid 0.3% $FeSO_4$ 0.5% + Boric acid 0.3%, T_{13}: NAA 50ppm + Ethrel 100ppm + $ZnSO_4$ 0.5%+ $FeSO_4$ 0.5% + Boric acid 0.3%.

per plant (table 6 and fig. 2). This is attributed to GA3 hastening flower induction and micronutrients

like Zinc and Boron regulating carbohydrate translocation and auxin synthesis, which builds food reserves and enhances fruit retention was coated by Prajapati *et al*. (2016) and these results are in accordance with the findings of Saima *et al.* (2014) in strawberry and Abhijith (2017) in aonla.

Significant improvements in fruit weight, length, diameter, and volume in T8 were driven by GA3-induced mesocarp cell enlargement and the role of Boron and Iron in cell division and photosynthetic accumulation. Additionally, the highest fruit set in T3 was due to GA3 diverting metabolites toward flowers to prevent abscission (fig. 2). Ultimately, the maximum fruit yield (20.77 kg/plant) in T8 (fig. 3) resulted from the combined effect of increased fruit size, weight and reduced fruit drop facilitated by optimized nutrient uptake and enzymatic activity. Similar findings were reported by (Makhmale and Delvadia. 2015) in custard apple.

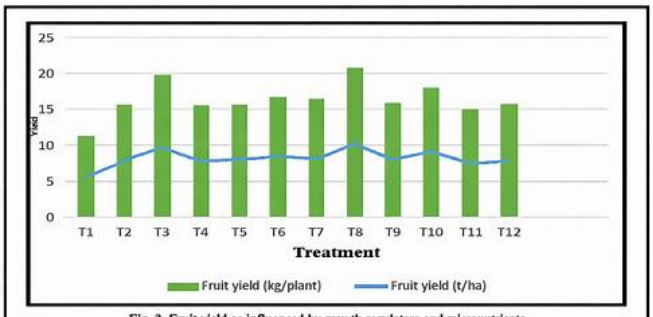

Fig. 3. Fruit yield as influenced by growth regulators and microuutrients

T_1: Control, T_2: GA_3 50ppm, T_3: GA_3 75ppm, T_4: NAA 75ppm, T_5: NAA 100ppm, T_6:Ethrel 100ppm, T_7: GA_3 50ppm+ $ZnSO_4$ 0.5%+ $FeSO_4$ 0.5% + Boric acid 0.3%, T_8: NA_4 75ppm + $ZnSO_4$ 0.5%+ $FeSO_4$ 0.5% + Boric acid 0.3% , T_9: NAA 75ppm+ $ZnSO_4$ 0.5%+ $FeSO_4$ 0.5% + Boric acid 0.3%, T_{10}: NAA 100ppm + $ZnSO_4$ 0.5%+ $FeSO_4$ 0.5% + Boric acid 0.3%, T_{11}:Ethrel 100ppm + $ZnSO_4$ 0.5%+ $FeSO_4$ 0.5% + Boric acid 0.3%, T_{12}: NAA 50ppm + Ethrel 100ppm + $ZnSO_4$ 0.5%+ $FeSO_4$ 0.5% + Boric acid 0.3%

Conclusion

Based on the results of the study, it is concluded that the different combination of foliar application of plant growth regulators and micronutrients showed a significant influence on plant growth, yield attributing parameters of the custard apple *cv.* Balanagar. Moreover, the plants treated with GA_3 75 ppm showed promising results in the growth parameters and the plants treated with GA_3 75 ppm + $ZnSO_4$ 0.5 %+ $FeSO_4$ 0.5 % + boric acid 0.3 % showed significant results in yield parameters of custard apple *cv.* Balanagar like number of days taken for flowering, number of fruits per plant, fruit length, fruit weight, fruit yield and so on.

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