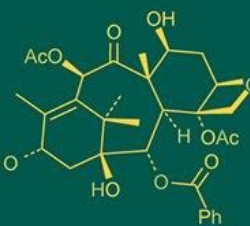
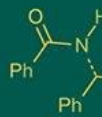
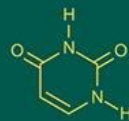
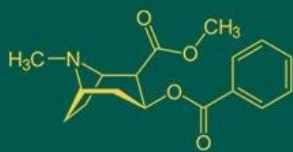


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Uracil and Chloramequat chloride assessed to improve yield and quality of hasta bahar produced sweet orange cv. Sathgudi

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Abstract

The experiment entitled Uracil and Chloramequat chloride assessed to improve yield and quality of hasta bahar produced sweet orange cv.Sathgudi. was carried out at Dr. Y.S.R.H.U -Citrus Research Station, Tirupathi, during the year 2024-2025. The experiment was laid out in a factorial randomized complete block design with two factors and two replications comprising of eighteen treatments. The factor one with nine levels of plant growth regulators viz., are Chloramequat chloride@1000 and 2000ppm, Mepiquat chloride@ 100 and 200ppm, Nitrobenzene@2 and 3ml/litre, Homobrassinosteroids@ 0.1and 0.2 ml/litre and control. The second factor with two levels of flower enhancing chemical uracil @ 50 ppm and without uracil. Among the treatment combination C₁U₁(CCC@1000 ppm and uracil@50ppm) showed significantly enhanced the yield parameters like fruit weight (159.85g), number of fruits per shoot (12.61), number fruits per tree (378.30), fruit yield (60.48 kg/tree) and also quality parameters like TSS(12.40°Brix), titratable acidity (0.45%), ascorbic acid (62.10 mg/100ml),juice (50.05%), total sugars (6.43%),reducing sugars(4.25%),non-reducing sugars(2.52%),TSS acid ratio (31.05) and shelf life (21.72 days) followed by C₂U₁ (CCC @ 2000ppm and uracil @ 50 ppm).

Keywords: Sweet orange, yield, quality, plant growth regulators (PGRS) and flower inducing chemicals, uracil

Introduction

In India, citrus ranks third in area and production after mango and banana and plays a vital role in the horticultural economy of the country. According to the Ministry of agriculture and pharmacy welfare (2024-25 advanced estimate), citrus is grown on about 11,20 thousand hectares with an annual production of 14,924. thousand metric tonnes. Sweet orange (*Citrus sinensis* Swingle) is the second most important citrus crop in India after mandarin and is grown extensively for its pleasing taste, high juice content and nutraceutical quality. At present, it occupies 11,29,01 thousand hectares with an annual production of 22,58,020 metric tonnes in Andhra Pradesh (Dept of horticulture,2023-24) Sweet orange is commercially cultivated in Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, Punjab, Madhya Pradesh and Assam, with Andhra Pradesh being a leading producer. Within the state, major sweet orange-growing districts are Anantapuramu, Prakasam, YSR Kadapa, Kurnool and Guntur, where the climate and soils are particularly favorable for cultivation (Sable *et al.*, 2022) [13].

Among the different cultivars, 'Sathgudi' is a commercially important variety widely cultivated in Andhra Pradesh and neighboring states. The fruits are medium-sized, nearly round to spherical in shape, with a smooth, moderately thick orange rind. The flesh is straw-colored to orange with 10-12 segments, producing juice of excellent flavor. Because of its high juice content and consumer preference, 'Sathgudi' has become one of the most popular sweet orange cultivars in the region. However, productivity in this variety is often hampered by irregular flowering, poor fruit set and low yields, particularly during the *Hasta Bahar* season (Ranganna *et al.*, 2017) [12].

Flowering in sweet orange generally occurs in three flushes: *Ambe Bahar* (January-February), *Mrig Bahar* (June-July) and *Hasta Bahar* (September-October). Of these, *Hasta*

Bahar is the most economically important as it results in summer harvests (April-May), when market demand is high and prices are remunerative. Nevertheless, in the southern coastal districts of Andhra Pradesh, inducing flowering during September-October is challenging due to the impact of the North-East monsoon, leading to irregular or poor flowering. This, combined with problems of excessive vegetative growth, shading and incomplete pollination, reduces productivity and profitability for farmers. Hence, regulating flowering and improving fruit set during *Hasta Bahar* is of great importance to ensure higher summer yields and better income for growers.

Plant Growth Regulators (PGRs) and chemicals have emerged as promising tools to manipulate plant physiology, regulate flowering, improve fruit set and enhance yield and fruit quality. Among these, Cycocel (Chlormequat Chloride), (Cheng *et al.*, 2025) [2] a gibberellin inhibitor, reduces vegetative growth, shortens internodes and promotes flower bud initiation by diverting assimilates towards reproductive structures (Muthupriya *et al.*, 2022) [11]. Mepiquat Chloride, (Fahmy *et al.*, 2023) [3] another anti-gibberellin compound, reduces excessive vegetative growth, enhances photosynthesis (Hanumatharaya *et al.*, 2022) [5] and helps synchronize flowering (Budensha *et al.*, 2022) [1]. Uracil, though not a conventional PGR, plays an important role in RNA synthesis and cell metabolism, stimulating cell division and floral differentiation. Nitrobenzene functions as a plant energizer, improving photosynthesis, nutrient uptake, flowering and fruit quality. (Kumar *et al.*, 2020) [9] Homobrassinosteroids, (Ghoneem *et al.*, 2024) [4] naturally occurring plant steroids, regulate growth and development while enhancing stress tolerance, flowering and fruit quality even under challenging environmental conditions (Singh *et al.*, 2022) [16]. Reports, including those of (Lakshmi *et al.*, 2014) [10], have emphasized the importance of these PGRs and chemicals in regulating flowering during *Hasta Bahar* and thereby improving yield and quality of sweet orange.

Materials and Methods

The experiment was conducted at Citrus Research Station, Tirupathi, on 10 year old sweet orange plants spaced with spacing of 6 X 6 meters. The experiment was carried out during of 2024-2025.

The study followed a Two-Factorial Randomized Block Design (FRBD) with 18 treatment combinations (T₁-T₁₈) and two replications, two plants per replication for each treatment. In factor one nine levels of plant growth regulators *viz.*,

- C₁: CCC @ 1000ppm,
- C₂: CCC @ 2000ppm,
- C₃: Mepiquat chloride @ 100ppm,
- C₄: Mepiquat chloride @ 200ppm,
- C₅: Nitrobenzene @ 2ml/litre,
- C₆: Nitrobenzene @ 3ml/litre,
- C₇: Homobrassinosteroids @ 0.1mg/litre,
- C₈: Homobrassinosteroids @ 0.2mg/litre,
- C₉: Control.

In factor two levels uracil combination of *viz.*, levels: U₀: without uracil, U₁: with uracil @ 50 ppm. Yield parameters included number of fruits per shoot, number of fruits per tree, fruit yield (kg/tree), fruit weight (g) and quality parameters are TSS (°Brix), Titratable acidity (%), Ascorbic acid (mg/100 ml), Juice (%), Total sugars (%), Reducing

sugars (%), Non-reducing sugars (%), TSS: Acid ratio and Shelf life (days).

Results and Discussion

Significant differences in number of fruits per shoot were observed among plant growth regulators and flower inducing chemicals and uracil. Maximum number of fruits per shoot was recorded in (T₁₀) C₁U₁-CCC @ 1000ppm and uracil @ 50ppm resulted 12.61 fruits when compared with (T₉) C₉U₀-Control and without uracil 5.29 fruits and followed by (T₁₁) C₂U₁-CCC @ 2000 ppm with uracil @ 50ppm is represented in Table 1. These findings align with Salomon *et al.*, 1981 [14], where CCC improved fruit set and compact fruit set and compact growth habit in citrus. Hussain *et al.*, 2017 [6], where uracil @ 25 ppm have increased the number of fruit per shoot. Table 1. represents that number of fruits per tree was significant were observed among plant growth regulators, flower inducing chemicals and uracil. Maximum number fruits per tree was in (T₁₀) C₁U₁-CCC @ 1000ppm and uracil @ 50ppm resulted 378.30 fruits when compared with (T₉) C₉U₀-Control and without uracil 158.70 fruits and followed by (T₁₁) C₂U₁-CCC @ 2000ppm and uracil @ 50 ppm. Similar findings Hussain *et al.*, 2017 [6], where uracil @ 25 ppm have increased the number of fruits per tree. Ranganna *et al.*, 2017 [12], where CCC @ 1000 ppm + GA₃+KNO₃ gave highest fruit number in sweet orange.

Significant differences in fruit weight (g) was observed among plant growth regulators flower inducing chemicals and uracil. Highest fruit weight was in (T₁₀) C₁U₁-CCC @ 1000ppm and uracil @ 50ppm observed is 159.85g when compared with (T₉) C₉U₀-Control and without uracil of 130.25 g and followed by (T₁₁) C₂U₁-CCC @ 2000ppm and uracil @ 50 ppm was in presented in the Table 1. The study conducted by Sable *et al.*, 2022 [13], CCC's treated fruits showed highest fruit weight. Hussain *et al.*, 2017 [6], where uracil @ 25 ppm have higher fruit weight. Table 1. represents that fruit yield was significant were observed among plant growth regulators flower inducing chemicals and uracil. Maximum fruit yield was in (T₁₀) C₁U₁-CCC @ 1000ppm and uracil @ 50ppm resulted 60.48kg when compare with the (T₉) C₉U₀-Control and without uracil 20.67 kg and followed by (T₁₁) C₂U₁-CCC @ 2000ppm and uracil @ 50 ppm. Field trails conducted by Hussain *et al.*, 2017 [6], where uracil @ 25 ppm and with CCC @ 1000ppm show maximum fruit yield.

Significant data wise differences in shelf life was observed among plant growth regulators flower inducing chemicals and uracil. maximum shelf life was in (T₁₀) C₁U₁-CCC @ 1000ppm and uracil @ 50ppm observed is 21.72 days when compare with the shelf life displayed in 14.53 days (T₉) C₉U₀-Control and without uracil and on par with (T₁₁) C₂U₁-CCC @ 2000ppm and uracil @ 50 ppm was in presented in the Table 2. Study conducted by Salomon *et al.*, 1982, CCC's treated fruits showed maximum shelf life. Hussain *et al.*, 2017 [6], where uracil @ 25 ppm have better storability.

Table 2. represents that TSS was significant were observed among plant growth regulators flower inducing chemicals and uracil. Maximum TSS was in (T₁₀) C₁U₁-CCC @ 1000ppm and uracil @ 50ppm resulted 12.40°B when we compare with (T₉) C₉U₀-Control and without uracil 8.95 °B. and followed by (T₁₁) C₂U₁-CCC @ 2000ppm and uracil @ 50 ppm. Field experiment conducted by Hussain *et al.*, 2017 [6], where uracil @ 25 ppm and with show maximum TSS.

Sable *et al.*, 2022^[13], CCC's treated fruits showed highest TSS. Significance differences in titratable acidity (%) was observed among plant growth regulators, flower inducing chemicals and uracil minimum titratable acidity was in (T₁₀) C₁U₁ -CCC @ 1000ppm and uracil @ 50ppm observed is 0.45% when compare with the 0.76 (T₉) C₉U₀-Control and without uracil and on par with (T₁₁) C₂U₁ -CCC@2000ppm and uracil @ 50 ppm was in presented in the Table 2. Experiment conducted by Ranganna *et al.*, 2017^[12], CCC's treated fruits showed lower acidity. Hussain *et al.*, 2017^[6], where uracil @ 25 ppm have balances sugar-acid. Significantly differences in TSS: Acid ratio was observed among plant growth regulators flower inducing chemicals and uracil in Table 4. Maximum TSS: Acid was in (T₁₀) C₁U₁ -CCC @ 1000ppm and uracil @ 50ppm observed is 31.05 when compare with TSS : Acid displayed in 8.74 (T₉) C₉U₀-Control and without uracil and followed by (T₁₁) C₂U₁ -CCC@2000ppm and uracil @ 50 ppm was in presented in the Table 3. Sable *et al.*, 1982, reported that the CCC's treated plants favorable TSS: Acid ratio. Hussain *et al.*, 2017^[6], where uracil @ 25 ppm, where TSS: Acid ratio favored.

The Ascorbic acid show significant difference was observed among plant growth regulators flower inducing chemicals and uracil. Maximum ascorbic acid was in (T₁₀) C₁U₁ -CCC @ 1000ppm and uracil @ 50ppm resulted 62.10 when compare 35.94 is resulted in (T₉) C₉U₀-Control and without uracil is with on par with (T₁₁) C₂U₁ -CCC@2000ppm and uracil @ 50 ppm. Experimental trails said that Ranganna *et al.*, 2017^[12], CCC's treated fruits showed maximum ascorbic acid content. Shukla *et al.*, 2019^[15] where uracil @ 50 ppm improved ascorbic acid. The Juice % among plant growth regulators, flower enhancing chemicals and uracil is having the significant difference was observed in Table 3. Highest juice 50.05% was in (T₁₀) C₁U₁ -CCC @ 1000ppm and

uracil @ 50ppm when compare with the juice 36.27% is displayed in (T₉) C₉U₀-Control and without uracil is on par with (T₁₁) C₂U₁ -CCC@2000ppm and uracil @ 50 ppm. The study trails said that Hussain *et al.*, 2017^[6], where CCC @ 1000 ppm and uracil @ 25 ppm have highest juice %.

Among plant growth regulators, flower enhancing chemicals and uracil the total sugars shows the significant difference was observed in (T₁₀) C₁U₁ -CCC @ 1000ppm and uracil @ 50ppm (6.43%) when compare with the total sugars 5.37% is displayed in (T₉) C₉U₀-Control and without uracil. on par with (T₁₁) C₂U₁ -CCC@ 2000ppm and uracil @ 50 ppm. Findings told that Kaur and kaur (2017)-uracil raised total sugars in guava. Salomon *et al.*, 1981-CCC increased dry matter and sugar content. Reducing sugars have the significant difference among the plant growth regulators, flower inducing chemical and uracil was observed in Table 3. Highest reducing sugar 4.23% was in (T₁₀) C₁U₁ -CCC @ 1000ppm and uracil @ 50ppm when compare with the reducing sugars 3.27% is displayed in (T₉) C₉U₀-Control and without uracil was on par with (T₁₁) C₂U₁ -CCC@2000ppm and uracil @ 50 ppm. The trails conducted by the Hussain *et al.*, 2017^[6], where sugar fractions improved. Sabel *et al.*, 2022- CCC treated plants shows improved sugar fractions. Among plant growth regulators, flower inducing chemicals and uracil the non-reducing sugars was observed significant difference in Table 3. Highest non-reducing sugars was 2.32% in (T₁₀) C₁U₁ -CCC @ 1000ppm and uracil @ 50ppm when compare with on-reducing sugars 1.94% is displayed in (T₉) C₉U₀-Control and without uracil was on par with (T₁₁) C₂U₁ -CCC@2000ppm and uracil @ 50 ppm. Experimental study said that Hussain *et al.*, 2017^[6], where showed balanced sugar profile noted. Ranganna *et al.*, 2017^[12], CCC's treated plants shows balanced sugar fractions.

Table 1: Effect of plant growth regulators and chemicals on yield parameters in sweet orange cv. Sathgudi.

Yield parameters												
	No. of fruits per shoot			No. of fruits per tree			Fruit weight (g)			Fruit yield (kg/tree)		
	U ₀	U ₁	Mean	U ₀	U ₁	Mean	U ₀	U ₁	Mean	U ₀	U ₁	Mean
C ₁	7.78	12.61	10.20	223.40	378.30	300.85	142.35	159.85	151.10	32.23	60.48	46.35
C ₂	7.56	12.00	9.78	227.80	360.00	293.90	141.50	157.35	149.42	32.105	56.64	44.37
C ₃	6.68	10.36	8.09	200.40	310.80	255.60	133.30	145.35	139.32	26.72	43.86	35.29
C ₄	6.64	10.26	7.95	199.20	307.80	253.50	131.30	144.25	137.77	26.15	44.40	35.27
C ₅	7.25	9.15	9.40	217.50	274.50	246.00	140.45	154.35	147.40	30.54	42.36	36.45
C ₆	7.16	8.29	9.21	214.80	248.70	231.75	139.35	153.55	146.45	29.78	38.18	33.98
C ₇	7.10	8.24	8.83	213.00	244.20	228.60	138.65	150.25	144.45	29.53	37.14	33.33
C ₈	7.05	7.11	8.65	211.50	213.30	212.40	136.85	148.05	142.45	28.94	31.57	30.25
C ₉	5.29	6.71	7.03	158.70	201.30	180.00	130.25	143.75	137.00	20.67	28.93	24.80
Mean	6.94	9.41	10.20	207.36	282.10		137.11	150.75		28.51	42.61	
Source	C	U	CXU	C	U	CXU	C	U	CXU	C	U	CXU
SEm±	0.061	0.029	0.086	0.537	0.253	0.759	0.392	0.185	0.555	0.011	0.005	0.016
CD@5%	0.183	0.086	0.258	1.614	0.761	2.283	1.180	0.556	1.669	0.034	0.016	0.048

Table 2: Effect of plant growth regulators and chemicals on quality parameters in sweet orange cv. Sathgudi.

Quality parameters												
	Shelf life			TSS (°Brix)			Titratable acidity (%)			Ascorbic acid (mg/100ml)		
	U ₀	U ₁	Mean	U ₀	U ₁	Mean	U ₀	U ₁	Mean	U ₀	U ₁	Mean
C ₁	18.25	21.72	19.98	10.34	12.40	11.37	0.62	0.45	0.53	51.00	62.10	56.55
C ₂	18.16	21.71	19.93	10.22	12.28	11.25	0.65	0.46	0.56	49.11	62.07	55.59
C ₃	15.46	19.33	17.39	9.86	11.52	10.69	0.68	0.57	0.63	39.11	56.84	47.98
C ₄	15.34	19.32	17.33	9.86	11.55	10.70	0.67	0.6	0.63	37.23	55.06	46.14
C ₅	17.18	20.65	18.91	10.20	12.25	11.22	0.65	0.48	0.56	47.00	61.24	54.12
C ₆	17.13	20.64	18.88	10.07	12.20	11.13	0.68	0.51	0.59	45.04	61.27	53.15
C ₇	16.37	19.68	18.03	9.45	11.83	10.64	0.64	0.54	0.59	42.74	59.9	51.32

C ₈	16.34	19.63	17.98	9.59	11.87	10.73	0.66	0.55	0.60	41.00	58.85	49.92
C ₉	14.53	18.57	16.55	8.95	10.45	9.70	0.76	0.63	0.69	35.94	52.83	44.38
Mean	16.53	20.14		9.84	11.81		0.67	0.53		43.13	58.90	
Source	C	U	CXU	C	U	CXU	C	U	CXU	C	U	CXU
SEm±	0.010	0.005	0.014	0.011	0.005	0.015	0.009	0.004	0.012	0.277	0.131	0.392
CD@5%	0.029	0.014	0.042	0.032	0.015	0.045	0.026	0.012	0.037	0.834	0.393	1.179

Table 3: Effect of plant growth regulators and chemicals on Fruit composition parameters in sweet orange cv. Sathgudi.

Fruit composition parameters												
	Juice (%)			Total sugars (%)			Reducing sugars (%)			Non-reducing sugars(%)		
	U ₀	U ₁	Mean	U ₀	U ₁	Mean	U ₀	U ₁	Mean	U ₀	U ₁	Mean
C ₁	44.24	50.05	47.14	5.65	6.43	6.04	3.85	4.23	4.04	2.13	2.32	2.23
C ₂	43.67	49.89	46.78	5.58	6.42	6.00	3.76	4.21	3.99	2.11	2.30	2.20
C ₃	38.46	47.18	42.82	5.43	6.13	5.78	3.37	4.01	3.69	2.01	2.14	2.08
C ₄	37.71	46.57	42.14	5.41	6.07	5.74	3.30	3.99	3.65	2.00	2.16	2.08
C ₅	42.46	49.26	45.86	5.53	6.29	5.91	3.65	4.13	3.89	2.09	2.26	2.17
C ₆	41.70	48.27	44.98	5.50	6.25	5.87	3.57	4.08	3.82	2.07	2.23	2.15
C ₇	40.26	47.79	44.028	5.47	6.20	5.83	3.47	4.06	3.77	2.05	2.20	2.12
C ₈	39.52	47.27	43.39	5.45	6.17	5.81	3.42	4.03	3.73	2.03	2.13	2.08
C ₉	36.27	46.18	41.22	5.37	5.76	5.56	3.27	3.95	3.61	1.94	2.15	2.04
Mean	40.47	48.05		5.49	6.19		3.52	4.08		2.05	2.21	
Source	C	U	CXU	C	U	CXU	C	U	CXU	C	U	CXU
SEm±	0.091	0.043	0.129	0.008	0.004	0.012	0.007	0.004	0.011	0.008	0.004	0.012
CD@5%	0.274	0.129	0.388	0.030	0.014	0.042	0.022	0.011	0.032	0.025	0.012	0.036

Table 4: Effect of plant growth regulators and chemicals on TSS: Acid ratio in sweet orange cv. Sathgudi.

TSS: Acid ratio			
	U ₀	U ₁	Mean
C ₁	14.85	31.05	22.95
C ₂	14.12	29.98	22.05
C ₃	11.28	18.44	14.86
C ₄	10.92	17.77	14.34
C ₅	13.17	28.49	20.83
C ₆	12.29	27.13	19.71
C ₇	11.40	22.99	17.19
C ₈	11.29	21.79	16.54
C ₉	8.74	15.71	12.23
Mean	12.00	23.70	
Source	C	U	CXU
SEm±	0.019	0.009	0.027
CD@5%	0.058	0.027	0.082

Conclusion

Among plant growth regulators and flower inducing chemicals and uracil. The treatment combination (T₁₀) C₁U₁ - CCC @ 1000ppm and uracil @ 50ppm was the best performer in the both of the yield and quality parameters followed by C₂U₁ - CCC@2000ppm and uracil @ 50 ppm. hence we conclude that (T₁₀) C₁U₁ - CCC @ 1000ppm and uracil @ 50ppm is the best combination treatment among the plant growth regulators and flower inducing chemicals and uracil

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