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Effect of Pusa hydrogel and plant growth regulators on growth, yield and quality parameters of strawberry (*Fragaria x ananassa* Dutch.) cv. Chandler

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Abstract

The present study was carried out in the year 2021-22 in Central Research farm, Department of Horticulture, Shri Durga Ji Post Graduate College, Chandeshwar, Azamgarh, Uttar Pradesh. The experiment was conducted in Randomized Block Design with 27 treatments replicated thrice. The treatments were T₀ (Control), T₁ (Pusa hydrogel-30 gram), T₂ (Pusa hydrogel -60 gram), T₃ (Cycocel (600 ppm)), T₄ (Cycocel (1200 ppm)), T₅ (Triacantanol (120 ppm)), T₆ (Triacantanol (170 ppm)), T₇ (Cycocel (600 ppm) + Pusa hydrogel-30 gram), T₈ (Cycocel (600 ppm) + Pusa hydrogel -60 gram), T₉ (Cycocel (1200 ppm) + Pusa hydrogel-30 gram), T₁₀ (Cycocel (1200 ppm)+ Pusa hydrogel -60 gram), T₁₁ (Triacantanol (120 ppm) + Pusa hydrogel -30 gram), On the basis of our finding it was found that treatment T₁₁ (Triacantanol (120 ppm) + Pusa hydrogel -30 gram) was found to be best in the terms of Plant height, no. of leaves, plant spread, petiole length, leaf length, leaf width, leaf area, chlorophyll content, leaf nutrient, days taken to first flower, flowers per plant, days taken to first fruit, fruit length, fruit width, fruit set %, fruit yield/plant.

Keywords: Cycocel, triacantanol, Pusa hydrogel, strawberry, quality parameters

Introduction

Strawberry (*Fragaria x ananassa* Duch.) is one of the most fascinating fruits of the world. It is a cross between two species of American wild strawberry: a large fruited species, *Fragaria chiloensis*, originally from Chile and *Fragaria virginiana*, originally from Virginia, USA. The chromosome no. in strawberry is $2n=2x= 56$. Strawberry belongs to the family Rosaceae. The commercially cultivated strawberry is an octaploid species. It is a short-lived (3-5 yrs.), perennial, vigorous, stoloniferous herb growing to 10-20 cm height with a spread of about 0.3-1.0 m. Leaves are trifoliate, on stalks which grow out from a central crown (a compacted stem, where many leaves are formed very close together; leaflets are oval-egg shaped, deep green with coarse serrations. Flowers are white, 1-2 cm wide, bisexual with approximately 30 stamens and approximately 300 pistils on a swollen, conical, yellowish receptacle. The first flower opens at the top and centre of the crown and produce the bigger fruits; flowers that open later produce the small fruits. The true fruit of the strawberry is an achene, which is a small, dry seed loosely attached to the swollen ovary wall (receptacle). The flesh of the strawberry is, in fact, the ovary wall with many fruits/seeds on its surface. The roots are shallow so plants need regular moisture but not water logging.

Cycocel is a plant growth regulator for ornamentals, including bedding plants and herbaceous crops. Cycocel enhances the crop's aesthetic appeal and improves durability during post production shipping and handling. Treated crops are more compact with shorter internodes, stronger stems, and greener leaves.

PUSA Hydrogel is a super absorbent polymer developed by Indian Agriculture Research Institute, New Delhi which has been commercialized by CUMI. PUSA Hydrogel a Cellulose based Hydrogel which absorbs water 300 times its own size. Its recommended to be applied under the soil and near the root zone.

1-Triacantanol is a fatty alcohol of the general formula $C_{30}H_{62}O$, also known as melissyl alcohol or myricyl alcohol. It is found in plant cuticle waxes and in beeswax. Triacantanol significantly increases the amount of chlorophyll in leaves, thereby improving the rate of photosynthesis. It increases the rate of cell growth and multiplication.

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Materials and Methods

The area of Azamgarh district comes under subtropical belt in the North east of Uttar Pradesh, which experience extremely hot summer and extremely cold winter. The maximum temperature of the location reaches up to 42 °C-45 °C and seldom falls as low as 4 °C – 5 °C. The relative humidity ranges between 20 to 94%. The average rainfall in this area is around 1013.4 mm annually. However, occasional precipitation is also not uncommon during winter months. The experiment was conducted with an objective to find out the best treatment for growth, yield and quality of strawberry along with economics of the different treatment. The Treatments were T₀ (Control), T₁ (Pusa hydrogel-30 gram), T₂ (Pusa hydrogel -60 gram), T₃ (Cycocel (600 ppm)), T₄ (Cycocel (1200 ppm)), T₅ (Triacantanol (120 ppm)), T₆ (Triacantanol (170 ppm)), T₇ (Cycocel (600 ppm) + Pusa hydrogel-30 gram), T₈ (Cycocel (600 ppm) + Pusa hydrogel -60 gram), T₉ (Cycocel (1200 ppm) + Pusa hydrogel-30 gram), T₁₀ (Cycocel (1200 ppm)+ Pusa hydrogel -60 gram), T₁₁ (Triacantanol (120 ppm) + Pusa hydrogel -30 gram).

Results and Finding

1. Vegetative Parameters

The maximum plant height was observed in the treatment T₁₁ (Triacantanol (120 ppm) + Pusa hydrogel -30 gram) with 18.22 cm followed by T₁₀ (Cycocel (1200 ppm) + Pusa hydrogel 60 gram) with 18.08 cm which was significantly superior to T₀ (Control) with 16.66 cm.

The maximum number of leaves was observed in the treatment T₁₁ (Triacantanol (120 ppm) + Pusa hydrogel -30 gram) with 11.70 followed by T₁₀ (Cycocel (1200 ppm) + Pusa hydrogel 60 gram) with 11.33 which was significantly superior to T₀ (Control) with 12.20.

The maximum plant spread was observed in the treatment T₁₁ (Triacantanol (120 ppm) + Pusa hydrogel -30 gram) with 22.19 cm followed by T₁₀ (Cycocel (1200 ppm) + Pusa hydrogel 60 gram) with 22.18 cm which was significantly superior to T₀ (Control) with 20.74 cm.

The maximum petiole length was observed in the treatment T₁₁ (Triacantanol (120 ppm) + Pusa hydrogel -30 gram) with 12.14 cm followed by T₁₀ (Cycocel (1200 ppm) + Pusa hydrogel 60 gram) with 12.04 cm which was significantly superior to T₀ (Control) with 8.62 cm.

The maximum number of flowers was observed in the treatment T₁₁ (Triacantanol (120 ppm) + Pusa hydrogel -30 gram) with 10.73 followed by T₁₀ (Cycocel (1200 ppm) + Pusa hydrogel 60 gram) with 10.41 which was significantly superior to T₀ (Control) with 9.60.

2. Earliness Parameter

The minimum days taken to first flowering was observed in the treatment T₁₁ (Triacantanol (120 ppm) + Pusa hydrogel -30 gram) with 63.58 days followed by T₁₀ (Cycocel (1200 ppm) + Pusa hydrogel 60 gram) with 64.05 days which was significantly superior to T₀ (Control) with 65.36 days.

The minimum days taken to first fruiting was observed in the treatment T₁₁ (Triacantanol (120 ppm) + Pusa hydrogel -30 gram) with 75.41 days followed by T₁₀ (Cycocel (1200 ppm) + Pusa hydrogel 60 gram) with 75.92 days which was significantly superior to T₀ (Control) with 78.03 days.

3. Fruiting Parameter

The maximum number of fruit was observed in the treatment T₁₁ (Triacantanol (120 ppm) + Pusa hydrogel -30

gram) with 5.87 followed by T₁₀ (Cycocel (1200 ppm) + Pusa hydrogel 60 gram) with 5.70 which was significantly superior to T₀ (Control) with 4.67.

The maximum fruit length was observed in the treatment T₁₁ (Triacantanol (120 ppm) + Pusa hydrogel -30 gram) with 5.36 cm followed by T₁₀ (Cycocel (1200 ppm) + Pusa hydrogel 60 gram) with 4.52 cm which was significantly superior to T₀ (Control) with 3.36 cm.

The maximum fruit width was observed in the treatment T₁₁ (Triacantanol (120 ppm) + Pusa hydrogel -30 gram) with 3.52 cm followed by T₁₀ (Cycocel (1200 ppm) + Pusa hydrogel 60 gram) with 3.42 cm which was significantly superior to T₀ (Control) with 2.71 cm.

The maximum fruit set % was observed in the treatment T₁₁ (Triacantanol (120 ppm) + Pusa hydrogel -30 gram) with 67.82% followed by T₁₀ (Cycocel (1200 ppm) + Pusa hydrogel 60 gram) with 66.19% which was significantly superior to T₀ (Control) with 41.37%.

4. Yield parameters

The maximum fruit yield per plant was observed in the treatment T₁₁ (Triacantanol (120 ppm) + Pusa hydrogel -30 gram) with 196.35 g followed by T₁₀ (Cycocel (1200 ppm) + Pusa hydrogel 60 gram) with 193.14 g which was significantly superior to T₀ (Control) with 108.52 g.

The maximum weight of fruit was observed in the treatment T₁₁ (Triacantanol (120 ppm) + Pusa hydrogel -30 gram) with 21.35 g followed by T₁₀ (Cycocel (1200 ppm) + Pusa hydrogel 60 gram) with 19.68 g which was significantly superior to T₀ (Control) with 10.91 g.

Discussion

Vegetative Parameters

Tucker (1926)^[15] reported that the application of stable nutrients increased vegetative growth which was observed by production of more runners and their branching had direct relation to the amounts of nutrients applied. The stable nutrients also increased vegetative growth in strawberry. the application of hydrogel minimizes the irrigation requirements of several crops by improving the water-holding capacity of the soil (Yang and Gress 1990)^[16] and it also enhances somatic cell division which leads to the vegetative growth of the strawberry. Plant growth regulators also helpful in the similar way by enhancing cell division, cell multiplication and cell elongation Macphail 1980^[4].

Earliness and Fruiting Parameters

The minimum number of days taken to flowering, and fruiting might be due to ample supply of the nutrients through hydrogel and plant growth regulators which leads to meiosis that is sex cell which leads to cell division and cell elongation because of which they have positive impact on earliness parameters. Similar findings were also reported by Clark *et al.* 2003 Verma *et al.* 2013 Johnson and Woodhouse and Khunte *et al.* 1990^[1, 13, 5].

Yield Parameters

Nutrients play an important role in improving productivity and quality of Strawberry. Added dose of hydrogel and plant growth regulators and other essential nutrients increased the vigor of plants, assimilating area, size of fruit, thereby resulting into higher weight of fruit. These results are in close conformity with the findings of Shinde *et al.*, 2008 Ghora *et al.* 2000 and Pant and Kumar 2004^[12, 2, 10].

Table 1: Effect of PUSA Hydrogel and plant growth regulators on Plant height, no. of leaves and plant spread.

Treatment	Plant Height				No. of leaves				Plant Spread				Petiole Length		
	30 DAS	60 DAS	90 DAS	120 DAS	30 DAS	60 DAS	90 DAS	120 DAS	30 DAS	60 DAS	90 DAS	120 DAS	30 DAS	60 DAS	90 DAS
T ₀	4.13	5.72	10.67	16.66	4.20	6.93	8.73	12.20	5.55	11.17	16.79	20.74	4.18	6.97	8.62
T ₁	5.67	7.63	12.00	18.28	4.20	6.30	8.00	11.90	5.93	11.55	17.12	21.07	6.56	10.25	11.16
T ₂	6.01	7.24	11.83	17.91	3.67	6.00	7.70	11.13	5.46	11.08	16.32	20.27	6.90	9.53	10.84
T ₃	5.07	6.25	10.99	17.28	4.03	6.17	8.13	11.50	13.09	18.71	17.79	21.74	7.16	10.96	10.41
T ₄	5.94	7.03	11.90	17.96	4.00	5.80	7.90	11.13	5.73	11.35	16.68	20.63	7.19	9.91	11.06
T ₅	4.57	6.69	11.11	17.38	4.00	5.97	8.03	11.30	6.41	12.03	17.67	21.62	6.91	10.25	10.53
T ₆	4.16	6.04	11.23	17.67	4.30	6.50	8.80	11.87	6.19	11.81	16.87	20.82	6.83	9.75	11.41
T ₇	4.86	6.24	10.66	18.02	3.50	5.93	7.60	11.20	6.35	11.97	16.72	20.67	6.24	10.69	11.15
T ₈	4.19	6.34	10.75	17.32	3.77	6.30	8.27	11.93	6.34	11.96	16.88	20.83	6.81	10.05	11.48
T ₉	4.43	5.96	10.89	17.69	4.20	6.80	8.80	12.73	6.09	11.71	17.48	21.43	7.35	10.41	10.82
T ₁₀	4.43	6.00	10.72	18.08	3.53	6.10	8.07	11.70	13.24	18.86	18.23	22.18	7.68	10.35	11.46
T ₁₁	4.53	6.19	10.82	18.22	2.90	5.67	7.57	11.33	6.37	11.99	18.24	22.19	6.85	10.39	10.48
F Test	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
C.D.@ 5%	0.77	1.95	2.44	0.98	0.25	0.35	0.42	0.68	0.75	0.95	0.102	1.21	1.83	1.862	0.891
SE.d	0.28	0.98	1.13	0.45	0.13	0.16	0.21	0.36	0.37	0.48	0.051	0.67	0.956	0.962	0.465

Table 2: Effect of PUSA Hydrogel and plant growth regulators on Petiole Length, Days taken to 1st flower, Number of flowers and Days taken to 1st fruiting of strawberry.

Treatment	Petiole length			Days taken to first flower	No. of Flowers				Days taken to first fruits
	30 DAS	60 DAS	90 DAS		80 DAS	90 DAS	100 DAS	110 DAS	
T ₀	4.18	6.97	8.62	65.36	2.15	4.87	5.33	9.60	78.03
T ₁	6.56	10.25	11.16	66.34	2.15	4.40	5.93	9.53	76.80
T ₂	6.90	9.53	10.84	67.24	1.98	4.33	5.57	10.03	77.67
T ₃	7.16	10.96	10.41	65.78	1.62	3.70	5.57	10.13	76.27
T ₄	7.19	9.91	11.06	67.27	2.15	4.63	5.07	9.70	77.77
T ₅	6.91	10.25	10.53	67.41	2.12	4.63	5.33	9.63	78.63
T ₆	6.83	9.75	11.41	65.09	2.02	3.47	6.47	10.03	78.77
T ₇	6.24	10.69	11.15	64.75	2.05	4.20	6.27	10.17	76.57
T ₈	6.81	10.05	11.48	66.03	1.85	3.83	5.30	10.33	77.33
T ₉	7.35	10.41	10.82	64.39	1.98	4.40	5.10	10.03	76.10
T ₁₀	7.68	10.35	11.46	68.02	1.88	4.17	5.53	10.73	78.40
T ₁₁	6.85	10.39	10.48	66.98	1.98	3.70	5.27	9.90	77.50
F Test	S	S	S	S	S	S	S	S	S
C.D	1.83	1.862	0.891	1.838	1.862	0.891	1.838	1.862	0.887
SE.d	0.956	0.962	0.465	0.96	0.982	0.465	0.96	0.982	0.463

Table 3: Effect of PUSA Hydrogel and plant growth regulators on Number of fruit, Fruit length, Fruit width, fruit set %, Fruit yield/plant and weight of fruit of strawberry.

Treatment	No. of fruits				Fruit length (mm)	Fruit width (mm)	Fruit set %	Fruit yield/plant (g)	Weight of fruit (g)
	85 DAS	100 DAS	115 DAS	130 DAS					
T ₀	0.60	1.17	1.80	4.67	3.43	2.91	38.09	108.52	10.91
T ₁	1.03	1.73	2.80	4.47	3.95	3.13	42.95	143.02	13.35
T ₂	1.17	1.83	2.43	4.73	4.00	3.30	45.26	141.97	15.95
T ₃	0.83	1.97	2.43	5.47	3.85	3.27	49.75	187.56	14.02
T ₄	0.93	1.67	2.90	4.73	4.21	3.05	48.34	150.65	18.37
T ₅	0.73	1.57	2.90	4.97	4.21	3.01	45.98	151.88	15.23
T ₆	1.17	1.63	2.73	5.17	4.14	2.87	46.03	155.44	15.73
T ₇	1.13	1.97	2.60	3.60	3.75	3.38	40.95	146.36	15.06
T ₈	1.00	1.90	3.07	5.43	3.78	3.34	49.66	150.30	15.79
T ₉	0.97	2.10	3.03	4.77	3.68	3.32	47.19	193.65	14.49
T ₁₀	1.10	1.70	3.30	5.43	4.46	3.17	51.68	149.39	17.83
T ₁₁	0.93	1.73	2.67	5.20	3.83	3.12	56.87	177.08	13.51
F Test	S	S	S	S	S	S	S	S	S
Cd @ 5%	0.406	0.837	0.962	0.406	0.837	0.902	0.4	0.826	0.404
SE.d.	0.212	0.437	0.482	0.212	0.437	0.456	0.209	0.431	0.210

Conclusion

On the basis of our experimental finding it was concluded that the treatment T₁₁ (Triacontanol (120 ppm) + Pusa hydrogel -30 gram) was found to be best in the terms of Vegetative parameters, earliness parameters, flowering and fruiting parameters, quality parameters and economics of the treatment.

Future Scope

Strawberry (*Fragaria x ananassa*) is a popular fruit crop, having gained significant interest in the past several decades, thus increasing demand for specialty crops. Depending on the cropping system used, strawberry production can be either annual or perennial and many improvements in management practices, breeding, and new

systems have helped to support the commercial strawberry industry. Pusa hydrogel' which is first indigenous semi-synthetic superabsorbent technology for conserving water and enhancing crop productivity and thereby increases the water use efficiency.

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