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Effect of pusa hydrogel and plant growth regulators on vegetative growth of strawberry (*fragaria x ananassa* dutch.) Cv. Chandler

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Abstract

Strawberry (*Fragaria × ananassa Duch.*) is a high-value fruit crop globally known for its rich nutritional profile and economic potential. However, its cultivation in India is challenged by shallow roots, low water retention soils, and environmental fluctuations. To ensure sustainable and profitable cultivation, innovations in water and nutrient management are critical. This study aimed to evaluate the individual and combined effects of Pusa hydrogel and plant growth regulators (Triacontanol and Cycocel) on the vegetative growth, flowering, fruiting, yield, and quality of strawberry cv. Chandler. It also assessed the economic viability of these treatments. The research was conducted over two growing seasons (2021–22 and 2022–23) at Shri Durga Ji Post Graduate College, Azamgarh, U.P., using a Randomized Block Design with 27 treatments replicated thrice. The treatments included various concentrations and combinations of Pusa hydrogel (25g, 50g), Triacontanol (100ppm, 150ppm), and Cycocel (500ppm, 1000ppm). Data were collected on plant height, number of leaves, plant spread, flowering time, fruit size and weight, yield per plant, and biochemical quality traits like TSS, sugars, and vitamin C content. Economic analysis was also performed. Treatment T20 [Triacontanol 170 ppm + Pusa hydrogel 60 g] showed the best performance in vegetative traits, including plant height (19.93 cm), highest number of leaves (15.43), plant spread (23.2cm), days taken to first flower (60.02 days) and number of flowers (25.43). The synergistic application of Pusa hydrogel and plant growth regulators significantly improved strawberry growth, yield, fruit quality, and economic returns. This approach offers a sustainable and resource-efficient strategy for strawberry cultivation, particularly in water-limited regions.

Keywords

Strawberry, Pusa Hydrogel, Plant Growth Regulators, Triacontanol, Cycocel, Yield Improvement.

1. Introduction

Fruits are a vital component of the human diet, owing to their palatability, high water content, and rich concentration of essential nutrients. They serve as primary sources of vitamins, minerals, dietary fiber, natural sugars, and bioactive compounds. Regular consumption of fruits has been proven to reduce the risk of various nutritional deficiencies and chronic diseases such as anemia, scurvy, night blindness, and cardiovascular conditions [1]. Among the wide array of fruits, strawberries (*Fragaria × ananassa Duch.*) have gained increasing attention for both their nutritional benefits and economic potential. Strawberries are widely appreciated for their unique flavor, bright red coloration, and aromatic appeal [2]. They are an excellent source of vitamin C, anthocyanins, ellagic acid, and phenolic compounds, which offer potent antioxidant, anti-inflammatory, and disease-preventive properties [3,4,5].

In India, strawberry cultivation has witnessed remarkable growth, especially in cooler hill stations like Nainital, Kullu, Solan, and Srinagar, and is now increasingly spreading to the plains of Maharashtra, Madhya Pradesh, and Karnataka. The crop offers high returns and a short fruiting cycle, making it particularly attractive to small and marginal farmers [6]. However, strawberry farming poses challenges due to its shallow root system, sensitivity to moisture stress, high nutrient requirements, and vulnerability to environmental fluctuations such as temperature extremes and erratic rainfall [3].

To mitigate these limitations, sustainable practices such as Integrated Nutrient Management (INM) and the application of hydrogels have gained prominence. INM combines the judicious use of chemical fertilizers with organic manures like farmyard manure, poultry manure, vermicompost, and biofertilizers such as *Azotobacter* and phosphate-solubilizing bacteria. This balanced nutrient approach not only improves soil fertility and structure but also enhances nutrient-use efficiency, crop yield, and environmental sustainability [8,9, 10].

Hydrogels, particularly Pusa Hydrogel developed by the Indian Agricultural Research Institute (IARI), offer a water-efficient solution by absorbing and storing large quantities of water and gradually releasing it to plant roots. These polymers are especially useful in sandy soils with low water retention, reducing the frequency of irrigation and minimizing nutrient leaching. Their use in strawberry cultivation leads to improved root development, enhanced nutrient uptake, and better plant growth under moisture-deficit conditions [11].

Additionally, Plant Growth Regulators (PGRs) such as triacontanol and cycocel play a significant role in enhancing crop performance. Triacontanol promotes photosynthesis, nutrient absorption, and biomass accumulation, thereby accelerating flowering and fruit set. Cycocel helps regulate vegetative growth, improves plant architecture, and enhances fruit firmness and shelf life. The integration of PGRs into strawberry farming systems can significantly improve productivity and fruit quality[12,13,14].

2. Materials And Methods

The present investigation titled ***"Effect of Pusa Hydrogel and Plant Growth Regulators on Growth, Yield and Quality Parameters of Strawberry (Fragaria × ananassa Duch.) cv. Chandler"*** was conducted during 2021–22 and 2022–23 at the Research Field of the Department of Horticulture, Shri Durga Ji Post Graduate College, Chandeshwar, Azamgarh, Uttar Pradesh. The study aimed to evaluate the impact of hydrogel and plant growth regulators on strawberry cultivation under Eastern U.P.'s agro-climatic conditions.

The experimental site is located in the Middle Gangetic Plain Region (Zone-II), characterized by alluvial soils ideal for horticultural crops. The soil is primarily sandy loam to loam, with moderate water retention and good aeration, having a pH between 6.8 and 7.4. Organic carbon is moderately low, nitrogen availability is low, and phosphorus and potassium are present in moderate to adequate quantities—necessitating the use of integrated nutrient management.

The region experiences a sub-tropical monsoon climate with hot summers and cool winters. Annual rainfall ranges from 1000 to 1200 mm, mainly during the Southwest monsoon (June–September). Temperatures vary significantly—from around 4–5°C in winter to above 42°C during peak summer. Abundant sunshine throughout the year supports robust photosynthetic activity.

3. Observations To Be Recorded

1) Plant height (cm)
2) Number of leaves per plant
3) Plant spread (cm)
4) Days taken to first flower
5) Number of flowers

4. Treatment Detail

Notation	Treatment details
T_0	Control
T_1	Pusa hydrogel-30gram
T_2	Pusa hydrogel -60gram
T_3	Cycocel (600 ppm)
T_4	Cycocel (1200 ppm)
T_5	Triacontanol (120 ppm)
T_6	Triacontanol (170 ppm)
T_7	Cycocel (600 ppm) + Pusa hydrogel-30gram
T_8	Cycocel (600 ppm) + Pusa hydrogel -60gram
T_9	Cycocel (1200 ppm) + Pusa hydrogel-30gram
T_{10}	Cycocel (1200 ppm)+ Pusa hydrogel -60gram
T_{11}	Triacontanol (120 ppm) + Pusa hydrogel -30gram
T_{12}	Triacontanol (120 ppm) +Pusa hydrogel -60gram
T_{13}	Triacontanol (120 ppm) +Cycocel (600 ppm)
T_{14}	Triacontanol (120 ppm) +Cycocel (600 ppm)+ Pusa hydrogel -30gram

T_{15}	Triacontanol (120 ppm) +Cycocel (600 ppm)+ Pusa hydrogel -60gram
T_{16}	Triacontanol (120 ppm) +Cycocel (1200 ppm)
T_{17}	Triacontanol (120 ppm) +Cycocel (1200 ppm)+ Pusa hydrogel -30gram
T_{18}	Triacontanol (120 ppm) +Cycocel (1200 ppm)+ Pusa hydrogel -60gram
T_{19}	Triacontanol (170 ppm) + Pusa hydrogel -30gram
T_{20}	Triacontanol (170 ppm) +Pusa hydrogel -60gram
T_{21}	Triacontanol (170 ppm) +Cycocel (600 ppm)
T_{22}	Triacontanol (170 ppm) +Cycocel (600 ppm)+ Pusa hydrogel -30gram
T_{23}	Triacontanol (170 ppm) +Cycocel (600 ppm) + Pusa hydrogel -60gram
T_{24}	Triacontanol (170 ppm) +Cycocel (1200 ppm)
T_{25}	Triacontanol (170 ppm) +Cycocel (1200 ppm)+ Pusa hydrogel -30gram
T_{26}	Triacontanol (170 ppm) +Cycocel (1200 ppm) + Pusa hydrogel -60gram

5. Results And Discussion

The results of the studies on the *"Effect of Pusa hydrogel and plant growth regulators on vegetative growth, fruit yield and quality of strawberry (Fragaria × ananassa Dutch.) cv. Chandler"* are briefly described here under.

Two field experiments were carried out during 2021-22 and 2022-23 at Research Field Department of Horticulture, Shri Durga Ji Post Graduate College, Chandeshwar, Azamgarh (U.P.) - 211007. This study was undertaken to examine the influence of Pusa hydrogel and plant growth regulators on vegetative growth of strawberry (*Fragaria × ananassa* Dutch) cv. Chandler. The experiment evaluation details are given below:

Effect of Pusa hydrogel and plant growth regulators on vegetative growth of strawberry (*Fragaria × ananassa* Dutch) cv. Chandler

The data on plant height (cm), number of leaves per plant, plant spread (cm) Days taken to first flower and No of flowers per plants of strawberry as influenced by Pusa hydrogel and plant growth regulators (Cycocel and Triacontanol) is presented in table and graphically depicted in fig.

It is clearly evident from the tables that there were significant differences among the treatments at 30, 60, 90 and 120 days after planting (DAP) in 1st year, 2nd year and pooled data. Increasing growth rate was observed from 30 DAP to 120 DAP in both the years of the study. The plant growth was very slow till 30th day's stage and thereafter it increased at faster rates between 60th to 90th days reaching the highest at 120th day.

As evident from tables the maximum plant height 19.23 cm, 20.98 cm and 20.10 cm, number of leaves per plant 14.95, 15.90 and 15.43, plant spread 22.86 cm, 23.54 cm and 23.20 cm, minimum days taken to first flower 61.38 days, 60.02 days and 60.7 days and maximum number of flowers per plant 24.62, 26.24 and 25.43 were recorded with the treatment **T20 – (Triacontanol 170 ppm + Pusa hydrogel 60g)** at 120 DAP for both the years of study 2021–22, 2022–23 and their pooled, it was closely followed by treatment **T12 [Triacontanol 120 ppm) + Pusa hydrogel 60g]** at 120 DAP where plant height 19.05 cm, 20.80 cm and 19.93 cm, number of leaves per plant 13.86, 14.81 and 14.34, plant spread 22.71 cm, 23.39 cm and 23.05 cm, maximum days taken to first

	Plant Height 120 DAT			No. of leaves 120 DAT			Plant spread 120 DAT			Days taken to first flower 120 DAT			Number of flowers per plant 120 DAT		
Treatments	**2021-2022**	**2022-2023**	**Pooled**	**2021-2022**	**2022-2023**	**Pooled**	**2021-2022**	**2022-2023**	**Pooled**	**2021-2022**	**2022-2023**	**Pooled**	**2021-2022**	**2022-2023**	**Pooled**
T0	17.22	18.97	18.1	11.23	12.18	11.71	20.74	21.42	21.08	66.77	65.41	66.09	21.51	23.13	22.32
T1	18.02	19.77	18.9	12.2	13.15	12.68	21.74	22.42	22.08	64.75	63.39	64.07	22.69	24.31	23.5
T2	18.39	20.14	19.27	12.77	13.72	13.25	22.02	22.7	22.36	63.91	62.55	63.23	23.28	24.9	24.09
T3	16.76	18.51	17.64	10.97	11.92	11.45	20.63	21.31	20.97	67.27	65.91	66.59	20.98	22.6	21.79
T4	16.66	18.41	17.54	10.43	11.38	10.91	20.27	20.95	20.61	67.41	66.05	66.73	20.78	22.4	21.59
T5	17.27	19.02	18.15	11.3	12.25	11.78	20.82	21.5	21.16	66.41	65.05	65.73	21.61	23.23	22.42
T6	17.27	19.02	18.15	11.23	12.18	11.71	20.74	21.42	21.08	66.43	65.07	65.75	21.55	23.17	22.36
T7	17.53	19.28	18.41	11.9	12.85	12.38	21.32	22	21.66	65.38	64.02	64.7	21.94	23.56	22.75
T8	17.61	19.36	18.49	11.93	12.88	12.41	21.43	22.11	21.77	65.36	64	64.68	21.95	23.57	22.76
T9	17.32	19.07	18.2	11.47	12.42	11.95	20.86	21.54	21.2	66.34	64.98	65.66	21.71	23.33	22.52
T10	17.28	19.03	18.16	11.4	12.35	11.88	20.83	21.51	21.17	66.35	64.99	65.67	21.65	23.27	22.46
T11	18.28	20.03	19.16	12.57	13.52	13.05	21.96	22.64	22.3	64.44	63.08	63.76	22.72	24.34	23.53
T12	19.05	20.8	19.93	13.86	14.81	14.34	22.71	23.39	23.05	63.58	62.22	62.9	24.16	25.78	24.97

T13	17.11	18.86	17.99	11.13	12.08	11.61	20.7	21.38	21.04	67.19	65.83	66.51	21.31	22.93	22.12
T14	17.67	19.42	18.55	11.93	12.88	12.41	21.44	22.12	21.78	65.24	63.88	64.56	21.99	23.61	22.8
T15	17.91	19.66	18.79	12.03	12.98	12.51	21.62	22.3	21.96	65.09	63.73	64.41	22.18	23.8	22.99
T16	16.79	18.54	17.67	11.1	12.05	11.58	20.64	21.32	20.98	67.26	65.9	66.58	21.02	22.64	21.83
T17	17.33	19.08	18.21	11.57	12.52	12.05	21.15	21.83	21.49	65.78	64.42	65.1	21.78	23.4	22.59
T18	17.32	19.07	18.2	11.5	12.45	11.98	21.07	21.75	21.41	66.03	64.67	65.35	21.75	23.37	22.56
T19	18.38	20.13	19.26	12.73	13.68	13.21	22.02	22.7	22.36	64.39	63.03	63.71	22.72	24.34	23.53
T20	19.23	20.98	20.11	14.95	15.9	15.43	22.86	23.54	23.2	61.38	60.02	60.7	24.62	26.24	25.43
T21	17.19	18.94	18.07	11.2	12.15	11.68	20.74	21.42	21.08	66.81	65.45	66.13	21.42	23.04	22.23
T22	17.69	19.44	18.57	11.93	12.88	12.41	21.59	22.27	21.93	65.23	63.87	64.55	22.01	23.63	22.82
T23	17.96	19.71	18.84	12.13	13.08	12.61	21.64	22.32	21.98	64.93	63.57	64.25	22.42	24.04	23.23
T24	17.09	18.84	17.97	11.13	12.08	11.61	20.67	21.35	21.01	67.24	65.88	66.56	21.05	22.67	21.86
T25	17.38	19.13	18.26	11.6	12.55	12.08	21.25	21.93	21.59	65.47	64.11	64.79	21.91	23.53	22.72
T26	17.41	19.16	18.29	11.87	12.82	12.35	21.26	21.94	21.6	65.43	64.07	64.75	21.92	23.54	22.73
F Test	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
C.D. @ 5%	0.98	2.73	1.855	0.68	1.63	1.16	1.21	1.89	1.55	1.838	0.478	1.158	6.453	8.073	7.263
S.Ed	0.45	2.2	1.325	0.36	1.31	0.84	0.67	1.35	1.01	0.96	-0.4	0.28	3.389	5.009	4.199

flower 63.58 days, 62.22 days and 62.9 days and minimum number of flowers per plant 24.16, 25.78 and 24.97 has been recorded in both the years of study 2015–16, 2016–17 and their pooled of the experiment.

The minimum plant height 16.66 cm, 18.41 cm and 17.54 cm, number of leaves per plant 10.43, 11.38 and 10.91, plant spread 20.27 cm, 20.95 cm and 20.61 cm, maximum days taken to first flower 67.41 days, 66.05 days and 66.73 days and minimum number of flowers per plant is 20.78, 22.40 and 21.59 were recorded in treatment T_4 [CCC (1200 ppm)] at 120 DAP for the years 2021–22, 2022–23 and pooled data respectively.

6. Conclusion

On the basis of present investigation, it is concluded that the treatment $\mathbf{T_{20}}$ (Triacontanol (150 ppm) + Pusa hydrogel 50 gram) was found best in terms of maximum growth parameters of strawberry. These findings of the experiment will be useful for the scientists and strawberry growers to improve their income by modern cultivation and better production of crop.

7. Competing Interests

Authors have declared that no competing interests exist.

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