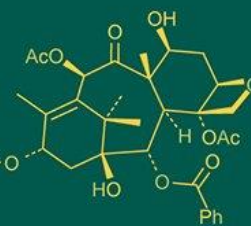
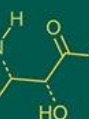
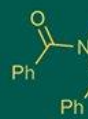


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Effect of pusa hydrogel enriched media on propagation, growth and flowering of pot chrysanthemum

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Abstract

The present experiment was carried to find out the effect of Pusa hydrogel enriched media on propagation and post planting growth of pot chrysanthemum at Floriculture Research Farm, ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat, India during August, 2024 to March, 2025. The experiment comprised of two different experiments which were laid out in Completely Randomized Design. The first experiment was conducted to identify the best suitable rooting media and appropriate concentration of Pusa hydrogel as a media amendment for raising healthy terminal rooted cuttings of pot chrysanthemum which comprised of three repetitions and seven treatments consisting different composition of Pusa hydrogel at different levels i.e., 0.1%, 0.3% and 0.5% with cocopeat and sand as a media along with control. Maximum survival percentage (97.99), number of roots per cutting (44.45), length of longest root (88.60 mm), fresh and dry weight of shoot (8.24 and 2.78 g) and fresh and dry weight of root (1.46 and 0.90 g) were noted maximum from the cuttings raised in rooting media cocopeat + Pusa hydrogel 0.1% (T₄). The second experiment was carried out to standardize the optimum amount of Pusa hydrogel in potting mixture for evaluating the effect of Pusa hydrogel on post planting growth of pot chrysanthemum and it contained three repetitions and six treatments having five different concentrations of Pusa hydrogel in potting mixture consisted soil and vermicompost in 2:1 v/v ratio along with control. Incremental plant height (10.44 and 18.59 cm), plant spread in N-S direction (13.75 and 25.23 cm) and in E-W direction (15.85 and 26.40 cm), leaf area (12.07 and 17.53 cm²) and number of lateral branches (4.67 and 7.75) were found maximum in plants grown in media incorporated with Pusa hydrogel 2.0% (T₅) at 30 and 60 days, respectively. Plants grown in control (T₆) took minimum days for 1st bud appearance (62.35). Whereas, maximum flowering duration (95.25 days), number of flowers per plant (83.25), flower diameter (3.80 cm), chlorophyll content (3.68 mg/100 g) and overall visual appearance (8.33) were noted with plants grown in media amended with Pusa hydrogel 2.0% (T₅). Maximum fresh weight of shoot (30.40 and 38.45 g), dry weight of shoot (13.38 and 19.82 g), fresh weight of root (10.00 and 11.12 g) and dry weight of root (3.28 and 2.64 g) were also recorded with the same treatment at 30 and 60 days, respectively. Different applications of Pusa hydrogel in media significantly affected dry matter assimilation, irrigation frequency and water use efficiency in pot chrysanthemum. Maximum net assimilation rate (6.37 g/m²/day) and relative growth rate (1.78 x 10⁻² g/g/day) were obtained with application of Pusa hydrogel 2.0% (T₅). The same treatment was found capable in reducing irrigation frequency (9.29 days) and increasing water use efficiency (49.38%) in pot chrysanthemum plants.

Keywords: Pot chrysanthemum, Pusa hydrogel, propagation media, potting mixture, irrigation frequency, water use efficiency

Introduction

Chrysanthemum (*Dendranthema grandiflora* Tzvelev.) belongs to family Asteraceae is popular commercial flower grown for cut flower, loose flower as well as pot plant throughout the world. 'Pot mums' hold a prominent position due to its high market demand, wider adoptability and ability to beautify indoor and outdoor places. With the urbanization and deletion of land in cities, flowering pot mums are successfully utilized to make outdoor and indoor environment attractive and fresh even in a small space. An increasing demand for container grown ornamental plants with in the country and for shipment to foreign countries, the pot mum's production has become the most profitable form of commercial chrysanthemum cultivation.

Growing media plays an important role in ensuring optimum plant growth by promoting growth and development of the root system (Awang *et al.*, 2009) ^[6]. The pot plants are highly susceptible to water stress due to less volume of soil or media available for their growth as compared to the plants grown in soil. Frequent watering to restricted soil volumes in pot plants causes leaching of nutrients (Kumar *et al.*, 2016) ^[13]. Along with this, media having suitable characteristics and much efforts for irrigation makes this small pot plant expensive. Thus, there is a need to find alternative water holding technologies which helps to maintain sufficient moisture level, especially in tropical climatic conditions where water demand is higher. Among different technologies, hydrogel can be the best suited material along with the growing media.

Hydrogels are cross-linked polymers with a hydrophilic group which have the capacity to absorb large quantities of water without dissolving in water. It can absorb 400-1500 times water by its dry weight (Madhu Bala, 2018) ^[15]. As hydrogel is hydrophilic in nature, it has good swelling capacity, lack of toxicity and controlled water release. It has ability to regulate moisture supply and potential to improve nutrient retention. Thus, it has an immense scope to use in media for growing ornamental pot plants. Pusa hydrogel has been developed by the Indian Council of Agricultural Research Institute, New Delhi. It has very high-water retention capacity, forms water stable aggregates and has life span of more than one year. Apart from this, it performs well even under high temperature up to 50 °C, yields simple products on decomposition and leaving no toxic substances into soil. It is cost effective as it is biodegradable and can be effectively used for 2-3 growing cycles.

The use of soil less media in pot plant cultivation has gained popularity due to its light weight properties and facilitating long distance transportation. Hydrogel can be added to the growing medium which can provide a consistent moisture supply without significantly increasing the weight of pots. Moreover, hydrogel application is becoming a crucial strategy for efficient water management in crops under climate change scenario.

Materials and Methods

The present experiment was carried out at Floriculture Research Farm, ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat during August, 2024 to March, 2025. The experiment comprised of two different experiments which were laid out in Completely Randomized Design (CRD). The first experiment was conducted to identify the best suitable rooting media and appropriate concentration of Pusa hydrogel as a media amendment for raising healthy terminal rooted cuttings of pot chrysanthemum which comprised of three repetitions and seven treatments consisting different composition of Pusa hydrogel at different levels *i.e.*, 0.1%, 0.3% and 0.5% with cocopeat and sand as a media along with control. Pot chrysanthemum variety 'Bidhan Mum' was selected for experiment and healthy terminal cuttings having 5-7 cm length were taken from the germplasm block of chrysanthemum from Floriculture Research Farm, ASPEE College of Horticulture, Navsari Agricultural University, Navsari for rooting in protrays. Protrays were kept in polytunnel made by arch having 5 m length, 1.5 m width and 1.05 m height from the ground level. Protrays were placed on bed, then arch is kept upon it and covered with

thick and transparent plastic sheet. Cuttings were placed in protrays during evening hours and light irrigation was given. After 30 days, healthy and well developed rooted plants were transplanted in pot having 10.3 litre volume capacity. Before planting of terminal rooted cuttings, pots were filled with potting mixture enriched with Pusa hydrogel according to the treatments. After that, transplanting was done in evening hours and irrigation was given. The observations were recorded on various vegetative and flowering parameters. Irrigation frequency and water use efficiency were also noted throughout the period of experimentation.

Results and Discussion

Effect of Pusa hydrogel on growth of cuttings in pot chrysanthemum

Maximum survival percentage (97.99), number of roots per cutting (44.45), length of longest root (88.60 mm), fresh and dry weight of shoot (8.24 and 2.78 g) and fresh and dry weight of root (1.46 and 0.90 g) were noted before planting in pots and recorded maximum from the cuttings raised in rooting media cocopeat + Pusa hydrogel 0.1% (T₄).

An increased survival percentage and improved growth of cuttings might be due to rooting media cocopeat amended with Pusa hydrogel which has high water holding capacity. Cocopeat has high porosity and higher amount of fibre in structure which increased aeration and surface area for roots to penetrate inside the media (Awang, 2009) ^[6]. Better aeration inside the media enhances root development and microbial activities. In addition, significant increase in root length with hydrogel might be due to adequate and continuous moisture to cuttings which encourage the cell elongation and hence the root growth. It also had positive effect on photosynthesis and nutrient remobilization. High water content in cells might cause opening of stomata for a longer time. Subsequently, good fixation of CO₂ resulted an increase in dry matter production hence increased fresh as well as dry weight of shoot. These results were corroborated with the findings of Anupama *et al.* (2007) ^[5] in chrysanthemum; Khadem *et al.* (2010) ^[11] in corn; Abdul *et al.* (2018) ^[1] in coleus; Deenavarman *et al.* (2018) ^[7] in *Syngonium podophyllum*; Verma *et al.* (2019) ^[22] in gerbera and Fazal *et al.* (2023) ^[8] in petunia.

Effect of Pusa hydrogel on vegetative characters in pot chrysanthemum

The maximum incremental plant height (10.44 and 18.59 cm), plant spread in N-S direction (13.75 and 25.23 cm) and in E-W direction (15.85 and 26.40 cm), leaf area (12.07 and 17.53 cm²) and number of lateral branches (4.67 and 7.75) were found maximum in plants grown in media incorporated with Pusa hydrogel 2.0% (T₅) at 30 and 60 days, respectively.

The increase in plant height, plant spread, leaf area and number of lateral branches in plants grown in Pusa hydrogel amended media were recorded due to high water availability and constant supply of nutrients to the growing plant at early vegetative stage through Pusa hydrogel application. Hydrogel crystals have ability to store the water by swelling and maintain sufficient amount of water inside the root zone and maintain higher amount of minerals and nutrients as well, which is beneficial at early growth stages. This increases the activity of cell division, cell elongation and cell expansion, ultimately leading to an increased vegetative growth. Similar results of growth improvement through

hydrogel application have been reported by Abdul *et al.* (2018) ^[1] in coleus; Thumar *et al.* (2021) ^[20] in chrysanthemum; Anil *et al.* (2023) ^[4] in tuberose and Aditya *et al.* (2023) ^[12] and Manjunatha *et al.* (2025) ^[16] in marigold.

Effect of Pusa hydrogel on flowering in pot chrysanthemum

An early first bud appearance (62.35) was recorded from the plants grown in control (T₆). Whereas, maximum flowering duration (95.84 days), number of flowers per plant (83.25), flower diameter (3.80 cm), chlorophyll content (3.68 mg/100 g) and overall visual appearance (8.33) were noted with plants grown in media amended with Pusa hydrogel 2.0% (T₅).

Ahmadian *et al.* (2024) ^[3] explained that delay in flower bud emergence might be due to higher amount of Pusa hydrogel in media which has increased amount of moisture storage in root zone. It could not provide stress condition which is necessary for flower bud differentiation. An increased flowering duration was observed in plants grown in Pusa hydrogel amended media because of the uninterrupted water availability which provides continuous supply of water and nutrients. Moreover, plants grown in Pusa hydrogel enriched media gave more flower flushes as compared to the control plants along with increasing flower quality. Increase in number of flowers might be due to higher number of lateral branches in plants grown in media amended with higher concentration of Pusa hydrogel. More number of branches ultimately increased number of flowers in plants. Addition of Pusa hydrogel accelerated uptake of minerals and ions which is beneficial for chlorophyll biosynthesis. Maximum overall visual appearance was noted with the plants grown in Pusa hydrogel enriched media due to longer flowering duration, a greater number of flowers and maximum flower diameter along with vigorous vegetative growth. This judgment was supported by the findings of Sharbazhery and Abu-Bakr (2017) ^[19] in *Verbena canadiensis*; Abdul *et al.* (2018) ^[1] in coleus; Thumar *et al.* (2021) ^[20] in chrysanthemum; Fazal *et al.* (2023) ^[8] in petunia and Manjunatha *et al.* (2025) ^[16] in marigold.

Effect of Pusa hydrogel on dry matter petitioning in pot chrysanthemum

Maximum fresh weight of shoot (30.40 and 38.45 g), dry weight of shoot (13.38 and 19.82 g), fresh weight of root (10.00 and 11.12 g) and dry weight of root (3.28 and 2.64 g) were recorded with the application of Pusa hydrogel 2.0% (T₅) at 30 and 60 days, respectively. Different applications of Pusa hydrogel in media significantly affected dry matter assimilation. Maximum net assimilation rate (6.37 g/m²/day) and relative growth rate (1.78 x 10⁻² g/g/day) were also obtained with the same treatment.

The fresh and dry plant biomass increased with increase in the Pusa hydrogel concentration in media which may be due to better growth and development of plants due to continuous moisture supply and increased availability of macro and micro nutrients. It increased photosynthetic rate which resulted into more assimilates production and

ultimately enhanced fresh and dry weight of shoot and roots. The results presented above aligned with the earlier findings from Anupama *et al.* (2007) ^[5] in chrysanthemum; Islam *et al.* (2011) ^[10] in corn; Abdul *et al.* (2018) ^[1] in coleus; Ahmadian *et al.* (2024) ^[3] in saffron and Kujur (2025) ^[12] in okra.

Net assimilation rate is the increase in dry biomass per unit leaf area and it is computed by the difference in dry biomass of plant over a period of time. It recorded maximum due to increase in dry biomass of plant noted during 30 and 60 days. Improvement in dry matter accumulation and physical properties of media by addition of hydrogel has also been confirmed by Hillary *et al.* (2011) ^[9] in *Agrostis stolonifera* and Verma *et al.* (2019) ^[22] in gerbera. Relative growth rate is the rate of growth per unit time and it also recorded higher owing to accelerated growth of plant by addition of Pusa hydrogel in media. Improvement in growth of plants grown in Pusa hydrogel enriched media has been confirmed by Kumar *et al.* (2016) ^[13] in pot mums and Aditya *et al.* (2023) ^[2] and Manjunatha *et al.* (2025) ^[16] in marigold.

Effect of Pusa hydrogel on irrigation frequency and water use efficiency in pot chrysanthemum

Potting media incorporated with Pusa hydrogel at 2.0% (T₅) exhibited reduced irrigation frequency (9.62 days) and enhanced water use efficiency (47.87%) noted throughout the period of experimentation.

The incorporation of Pusa hydrogel in media improved physical properties of soil; most importantly, water holding capacity. After irrigation, swollen hydrogel crystals provide constant moisture supply to plants between two successive irrigations which reduced irrigation frequency in pot chrysanthemum plants as compare to the control. A reduced watering frequency in hydrogel amended media has also been observed and reported by Anupama *et al.* (2007) ^[5] in chrysanthemum; Abdul *et al.* (2018) ^[1] in coleus; Deenavarman *et al.* (2018) ^[7] in *Syngonium*; Madhu Bala (2018) ^[15] in *Philodendron xanadu* and Patel *et al.* (2025) ^[18] in *Nephrolepis cordifolia*.

Water use efficiency is the ratio of water utilized for the plant biomass production in pot chrysanthemum plant. It can be used as the indicator of showing effectiveness of media for the growth and development in plants. Significantly, increasing water use efficiency has been observed with the increasing concentration of Pusa hydrogel in media. Due to rich nutritional status and higher water content, luxuriant plant growth was obtained in plants grown in hydrogel enriched media which ultimately increased plant biomass. Also, the reduced irrigation frequency led to reduction in total water consumed during the entire growth period as compared to the control. As water use efficiency is the ration between these two characters, it increased with the increase in Pusa hydrogel concentration in media. Above results are supported by the findings of Nazarli *et al.* (2010) ^[17] in sunflower; Islam *et al.* (2011) ^[10] in corn; Madhu Bala (2018) ^[15] in *Philodendron xanadu*; Trisha Roy *et al.* (2019) ^[21] in wheat and Kumar *et al.* (2021) ^[14] in Kinnow mandarin.

Table 1: Effect of Pusa hydrogel application on growth of cuttings in pot chrysanthemum

Treatments	Survival percentage	Number of roots per cutting	Length of longest root (mm)	Fresh weight of shoots (five)	Dry weight of shoots (five)	Fresh weight of roots (five)	Dry weight of roots (five)
T ₁ : Sand + Pusa hydrogel 0.1%	88.66	33.93	75.71	5.88	1.95	0.95	0.55
T ₂ : Sand + Pusa hydrogel 0.3%	90.66	35.58	77.07	6.39	2.01	1.29	0.63
T ₃ : Sand + Pusa hydrogel 0.5%	96.11	41.98	85.47	6.85	2.17	1.35	0.72
T ₄ : Cocopeat + Pusa hydrogel 0.1%	97.99	44.45	88.60	8.24	2.78	1.46	0.90
T ₅ : Cocopeat + Pusa hydrogel 0.3%	96.77	39.08	79.27	7.63	2.48	1.37	0.86
T ₆ : Cocopeat + Pusa hydrogel 0.5%	86.77	30.83	72.67	5.79	1.65	0.74	0.48
T ₇ : Control	81.66	30.35	68.00	5.07	1.39	0.64	0.29
Mean	91.23	36.6	78.11	6.55	2.06	1.11	0.63
SEm±	2.17	1.05	1.04	0.14	0.05	0.02	0.01
CD at 5%	6.60	3.19	3.17	0.43	0.16	0.08	0.05
CV%	4.13	4.98	2.31	3.75	4.42	3.96	4.08

Table 2: Effect of Pusa hydrogel application on vegetative characters in pot chrysanthemum

Treatments	Incremental plant height (cm)			Plant spread (N-S) (cm)		Plant spread (E-W) (cm)		Leaf area (cm ²)		Number of lateral branches	
	Initial	30 DAP	60 DAP	30 DAP	60 DAP	30 DAP	60 DAP	30 DAP	60 DAP	30 DAP	60 DAP
T ₁ : Pusa hydrogel 0.2%	5.54	6.93	11.15	9.04	17.55	11.56	21.47	8.92	11.87	2.60	4.93
T ₂ : Pusa hydrogel 0.5%	5.24	7.21	12.99	10.19	20.31	12.40	23.25	9.56	12.84	3.20	5.70
T ₃ : Pusa hydrogel 1.0%	5.37	7.94	14.54	12.13	22.53	13.42	24.11	10.20	14.15	3.80	6.50
T ₄ : Pusa hydrogel 1.5%	5.37	9.72	17.35	13.32	24.31	15.21	25.36	11.13	16.50	4.32	6.94
T ₅ : Pusa hydrogel 2.0%	5.50	10.44	18.59	13.75	25.23	15.85	26.40	12.07	17.53	4.67	7.75
T ₆ : Control	5.46	6.39	9.48	7.26	13.74	10.56	19.38	7.93	10.31	2.21	4.41
Mean	5.41	8.11	14.02	10.95	20.61	13.17	23.33	9.97	13.87	3.47	6.04
SEm±	0.24	0.26	0.44	0.32	0.53	0.23	0.75	0.19	0.28	0.10	0.17
CD at 5%	NS	0.81	1.37	0.98	1.65	0.71	2.32	0.58	0.86	0.31	0.53
CV%	7.70	5.62	5.49	5.05	4.50	3.04	5.58	3.26	3.48	5.01	4.91

Table 3: Effect of Pusa hydrogel application on flowering in pot chrysanthemum

Treatments	Days taken to 1 st bud appearance	Flowering duration (days)	Number of flowers per plant	Flower diameter (cm)	Chlorophyll content (mg/100 g)	Visual appearance
T ₁ : Pusa hydrogel 0.2%	66.60	71.86	41.48	2.31	2.45	4.33
T ₂ : Pusa hydrogel 0.5%	70.36	77.24	53.41	2.72	2.78	5.33
T ₃ : Pusa hydrogel 1.0%	74.42	82.38	60.83	3.05	3.03	6.17
T ₄ : Pusa hydrogel 1.5%	78.44	88.63	72.20	3.37	3.37	7.67
T ₅ : Pusa hydrogel 2.0%	82.55	95.25	83.25	3.80	3.68	8.50
T ₆ : Control	62.35	66.64	31.31	2.12	2.14	3.33
Mean	72.45	80.33	57.08	2.89	2.91	-
SEm±	1.36	1.50	1.01	0.05	0.07	-
CD at 5%	4.21	4.63	3.11	0.16	0.21	-
CV%	3.26	3.24	3.06	3.16	4.16	-

Table 4: Effect of Pusa hydrogel application on dry matter partitioning in pot chrysanthemum

Treatments	Fresh weight of shoot (g)		Dry weight of shoot (g)		Fresh weight of root (g)		Dry weight of root (g)		Net assimilation rate (g/m ² /day)	Relative growth rate (x 10 ⁻² g/g/day)
	30 DAP	60 DAP	30 DAP	60 DAP	30 DAP	60 DAP	30 DAP	60 DAP		
T ₁ : Pusa hydrogel 0.2%	19.38	28.78	8.33	12.37	5.32	7.08	1.20	1.31	5.02	1.51
T ₂ : Pusa hydrogel 0.5%	22.60	31.52	9.04	14.12	6.50	7.78	1.82	1.77	5.23	1.56
T ₃ : Pusa hydrogel 1.0%	24.51	33.56	9.89	15.55	7.30	8.69	2.56	2.08	5.24	1.60
T ₄ : Pusa hydrogel 1.5%	25.49	35.78	10.74	16.59	7.96	9.33	2.72	2.24	6.00	1.53
T ₅ : Pusa hydrogel 2.0%	30.40	38.45	13.38	19.82	10.00	11.12	3.28	2.64	6.37	1.78
T ₆ : Control	17.41	28.22	7.52	11.74	4.48	6.36	0.89	1.08	4.99	1.50
Mean	23.30	32.72	9.82	15.03	6.93	8.39	2.08	1.85	5.47	1.58
SEm±	0.52	0.79	0.25	0.38	0.14	0.19	0.04	0.04	0.20	0.07
CD at 5%	1.60	2.45	0.77	1.16	0.45	0.59	0.13	0.14	0.63	0.21
CV%	3.87	4.21	4.41	4.33	3.63	3.96	3.56	4.19	6.43	7.63

Table 5: Effect of Pusa hydrogel application on irrigation frequency and water use efficiency in pot chrysanthemum

Treatments	Irrigation frequency (days)	Water use efficiency (%)
T ₁ : Pusa hydrogel 0.2%	5.14	19.82
T ₂ : Pusa hydrogel 0.5%	6.29	31.10
T ₃ : Pusa hydrogel 1.0%	8.10	34.66
T ₄ : Pusa hydrogel 1.5%	8.66	44.24
T ₅ : Pusa hydrogel 2.0%	9.29	49.38
T ₆ : Control	3.50	14.58
Mean	6.83	32.30
SEm±	0.14	1.02
CD at 5%	0.45	3.15
CV%	3.68	5.49

Conclusion

From the result of the foregoing discussion, it can be concluded that cocopeat media amended with 0.1% Pusa hydrogel has been found to be more efficient for the propagation of healthy terminal rooted plants. Furthermore, potting media amended with Pusa hydrogel 2.0% can be effectively utilized for better plant growth and flowering with improved overall pot appearance. It also saved around three times water along with reduced irrigation frequency and enhanced water use efficiency in pot chrysanthemum.

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