

Evaluated the effect of hydrogel on physio- chemical and microorganism properties of potting media in roof top cultivation of ridge gourd

Abstract

The present study was done to evaluate the physico- chemical and microorganism of growing media containing hydrogel, sand, cocopeat, vermiculite, perlite and vermicompost for cultivation of ridge gourd on rooftop. Herein, growing media GM 5 (sand + vermicompost + hydrogel + cocopeat + vermiculite and perlite (3: 2.5: 2: 2: 0.5) showed significant effect on chemical properties EC (1.85 dS m^{-1}), pH (5.03), total organic carbon (0.843%) and physical properties bulk density (0.425 g cm^{-3}), total porosity (51%), maximum level of water holding capacity (66.76 mm). Similarly, microbiota population at 75th day and 150th day was significantly recorded in GM 5 (sand + vermicompost + hydrogel + cocopeat + vermiculite and perlite (3: 2.5: 2: 2: 0.5) bacteria population ($72.76 \times 10^6 \text{ cfu g}^{-1}$), $77.44 \times 10^6 \text{ cfu g}^{-1}$), fungus population (40.56cfu, 44.56cfu), actinomycetes population ($77.44 \times 10^4 \text{ cfu g}^{-1}$), $77.44 \times 10^4 \text{ cfu g}^{-1}$) as compared to control. The obtained results claim that sand + vermicompost + hydrogel + cocopeat + vermiculite and perlite act as bio stimulant to nutrient.

Introduction

Any potting media comprised of air, water and supplements to help the plant in proper growth and development (Paul, 2000). Proper distribution of air, water and solid in a container depends upon various physical and chemical properties of growing media. Moreover, at every stage of plant growth, water deficit stress can reduce the uptake of nutrients by plant and also the transport of the nutrients in soil and plant, which in turn reduces the plant's carbon and dry matter. Therefore, growing media play crucial role to estimate the function ability and soil organic content that will affect restored vegetation communities during critical stage of development. Moreover, activities of soil microbia can be used as significant indicator for improving the uptake of nutrients by plants. In most of the media N, P, K are mainly present in organic form but still

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unavailable for plants to uptake. Microorganism through numerous mechanisms converts nutrients into available form through solubilization, mineralization, desorption, diffusion etc. Therefore, keeping view of above facts the present study was conducted to investigate the effect of growing media with different proportion of EF polymer (treatment) on physio-chemical properties of media and soil microbiota in roof top cultivation of ridge gourd

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Material and methods

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Seed material and treatment

The present study was conducted at Department of Horticulture, RCA, MPUAT, Udaipur. It was laid in EF bags during February to July 2022 on roof top of building. The variety ArkaPrasan was purchased from IIHR, Bangalore, EF polymer was purchased from EF polymer private limited situated at Bhopal Pura, Udaipur. The experiment was laid out in complete randomized block design having ten treatments and three replications considering thirty EF bags having two plants in each. Experimental treatments were i.e. GM₁ [Control: sand + vermicompost + coco-peat + vermiculite and perlite (3: 2.5:2.5: 0.5)], GM₂ [Sand + vermicompost + hydrogel + coco-peat + vermiculite and perlite (3: 2.5: 3.5: 0.5: 0.5)], GM₃ [Sand+ vermicompost + hydrogel + coco-peat + vermiculite and perlite (3: 2.5: 2.25: 1.75: 0.5)], GM₄ [Sand + vermicompost + hydrogel + coco-peat + vermiculite and perlite (3: 2.5: 1.5: 2.5: 0.5)], GM₅ [Sand+ vermicompost + hydrogel + coco-peat + vermiculite and perlite (3: 2.5: 2: 2: 0.5)], GM₆ [Sand + vermicompost + hydrogel + coco-peat + vermiculite and perlite (3: 2.5: 0.5: 3.5: 0.5)], GM₇ [Sand + vermicompost + hydrogel + coco-peat + vermiculite and perlite (3: 2.5: 1: 3: 0.5)], GM₈ [Sand + vermicompost + hydrogel + coco-peat + vermiculite and perlite (3: 2.5: 2.5: 1.5: 0.5)], GM₉ [Sand + vermicompost + hydrogel + coco-peat + vermiculite and perlite (3: 2.5 :1.75 :2.25 : 0.5)] and GM₁₀ [Sand + vermicompost + hydrogel + coco-peat + vermiculite and perlite (3: 2.5: 3: 1: 0.5)].

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Preparation of growing media samples

Media 5.5 kg were filled in EF bags having sand, vermicompost and vermiculite-perlite mixture (3:2.5:0.5) ratio while cocopeat and hydrogel ratio of dosage were (3.5, 2.5, 1.5, 0.5, 1, 2.5, 1.75, 3 respectively).

Comment [SR38]: 5.5 kg of media containing sand, vermicompost and vermiculite-perlite mixture at the ratio of 3:2.5:0.5 respectively were filled in EF bags while, the cocopeat and hydrogel were applied @ 3.5, 2.5, 1.5, 0.5, 1, 2.5, 1.75 and 3).

Measurement of physical properties of growing media

Sample from growing media pH was measured by Digital pH meter (Criso, pH meter GLP 21, Bracelona, Spain) which was calibrated with pH 4 and 7 buffer at room temperature

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(23 ± 2°C), EC by Conductivity bridge meter (Model ORION 105-Range 0 to 199.99 dSm-1 ± 0.01, USA (Wilcox, 1950), Bulk Density and particle density measured Core sampler method given by Piper (1950), total organic carbon content in media was estimated by (Walkely and Black, 1947), water holding capacity, was measured gravimetric method given by Veihmeyer and Hendrickson (1954). Total porosity (%) was calculated by the following formula: -

$$1 - \left(\frac{\text{Bulk Density}}{\text{Particle density}} \times 100 \right)$$

Measurement of microbiota in growing media

Samples from growing media at (0-15 cm depth) were collected at 75 and 150 days after transplanting the crop in each growing EF bags for analysis. The samples were stored in plastic bag and were taken to lab where samples were sieved 2 mm mesh size, homogenized and stored at 4°C. Microbiota: bacteria, fungal and actinomycetes population were estimate by standard plate count method for fungal Martin, 1950 was used while for bacteria and actinomycetes nutrient agar medium was used (Allen, 1959). Microbial population was calculated and expressed as number of cells per gram growing media

Statistical Analysis

All the analysis were done in CRD (completely random design) with JMP software version 12 (SAS, 2010) using Karmer HSD test. The experiment was performed with 10 treatments and three replicate. Different parameters were represented as SD mean ±.

Result and Discussion

Effect of hydrogel on physical properties of growing media

The pH and EC are two important properties of growing media as these parameters significantly influence nutrient uptake. Growing media GM₅ [Sand+ vermicompost + hydrogel + Cocopeat +vermiculite and perlite (3: 2.5: 2: 2: 0.5)] significantly affect EC (1.85 dS/m), pH (5.03) total organic content (0.843 %) as compared to control (Table 1). Researchers have reported that hydrogels with high water holding capacity can reduce the

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negative effects of water deficit stress on plants. Improving the uptake of nutrients by plants (due to negative charge in the hydrated state that absorbs some cations in the soil and gradually provide them to the plant). Similar results reported by Ahraret *et al.* (2009), Montesano *et al.* (2015), and Varma *et al.* (2019)

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Table-1 Effect of hydrogel on chemical properties of growing media

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Treatments	pH	EC (dS/m)	Organic Carbon (%)
GM ₁	6.71 ± 0.077 ^A	1.85 ± 0.005 ^A	0.73 ± 0.0057 ^F
GM ₂	5.77 ± 0.003 ^{DE}	1.75 ± 0.003 ^{BC}	0.75 ± 0.0033 ^{DEF}
GM ₃	6.09 ± 0.024 ^{BCD}	1.75 ± 0.005 ^{BCD}	0.79 ± 0.012 ^{BCD}
GM ₄	6.19 ± 0.071 ^{BC}	1.48 ± 0.015 ^E	0.81 ± 0.0057 ^{ABC}
GM ₅	6.61 ± 0.084 ^A	1.76 ± 0.011 ^{BC}	0.84 ± 0.012 ^A
GM ₆	5.60 ± 0.063 ^E	1.7 ± 0.006 ^D	0.74 ± 0.0033 ^{EF}
GM ₇	6.08 ± 0.053 ^{BCD}	0.73 ± 0.017 ^F	0.78 ± 0.006 ^{CDE}
GM ₈	5.88 ± 0.057 ^{CDE}	1.78 ± 0.008 ^B	0.77 ± 0.0057 ^{CDEF}
GM ₉	6.37 ± 0.135 ^{AB}	1.76 ± 0.005 ^{BC}	0.83 ± 0.0057 ^{AB}
GM ₁₀	5.77 ± 0.058 ^{DE}	1.72 ± 0.005 ^{CD}	0.75 ± 0.018 ^{DEF}

Effect of hydrogel on physical properties of growing media

The study clearly showed that hydrogel water absorbent significantly influenced in GM₅ [Sand+ vermicompost + hydrogel + Cocopeat +vermiculite and perlite (3: 2.5: 2: 2: 0.5)]. Moreover, analysis of variance showed that hydrogel application reduced 0.425g/cm³ (Bulk Density), 51% (porosity) and increased 66.76 mm (water holding capacity) in growing media (GM₅) (table 2) as compared to control GM₁ (Table 2). Obtained results are in agreement with the results Agabaet *et al.* (2010), in which hydrogel application lead to better plant growth and higher yield. Additional reduced water losses. Moreover, Bharadwaj *et al.*, 2007 reported that swelling of polymer duration saturation, ultimately decrease spore space between the soil particles. Several studies (Guilherme *et al.*, 2015; Ahmed, 2015) reported that water absorbency of hydrogel is attributed by high molecular weight, high negative charge and for its hydrophilic functional groups, i.e. carboxyl, hydrogel and

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sulphonic group. Therefore, hydrogel in growing media improved physical properties of growing media.

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Table-2 Effect of hydrogel ion physical property of growing media

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Treatments	BD (g/cm ³)	Pore space (%)	Maximum water holding capacity (%)
GM ₁	0.55 ± 0.007 ^A	37.66 ± 0.88 ^F	48.96 ± 0.46 ^E
GM ₂	0.49 ± 0.005 ^{BC}	40.66 ± 0.88 ^{EF}	53.2 ± 1.81 ^{DE}
GM ₃	0.47 ± 0.006 ^{BCD}	47 ± 0.57 ^{ABC}	61.93 ± 1.48 ^{ABC}
GM ₄	0.44 ± 0.01 ^{CD}	49.66 ± 1.20 ^{AB}	64.5 ± 1.95 ^{AB}
GM ₅	0.42 ± 0.006 ^D	51 ± 1.15 ^A	66.76 ± 0.72 ^A
GM ₆	0.49 ± 0.02 ^B	42 ± 0.57 ^{DEF}	54.5 ± 1.36 ^{DE}
GM ₇	0.46 ± 0.004 ^{BCD}	45 ± 0.57 ^{BCDE}	56.76 ± 1.12 ^{CD}
GM ₈	0.48 ± 0.006 ^{BC}	46.33 ± 0.88 ^{ABCD}	58.43 ± 0.63 ^{BCD}
GM ₉	0.44 ± 0.014 ^{CD}	50.66 ± 0.88 ^A	64.06 ± 2.01 ^{AB}
GM ₁₀	0.46 ± 0.001 ^{BCD}	44.33 ± 1.45 ^{CDE}	54.9 ± 1.65 ^{CDE}

Effect of hydrogel on Microbiota at 75 and 150 days after transplanting

In present study, significant ($p \leq 0.05$) increase in bacteria, fungus and actinomycetes was noticed at the 75 days and at harvesting. Moreover, maximum population of bacteria ($72.76 \times 10^6 \text{ cfug}^{-1}$), fungus ($40.56 \times 10^4 \text{ cfug}^{-1}$) and actinomycetes ($77.44 \times 10^4 \text{ cfug}^{-1}$) were noticed in GM₅ [Sand+ vermicompost + hydrogel + Cocopeat + vermiculite and perlite (3: 2.5: 2: 2: 0.5)] as compared to control (Table 3). Similarly, on 150 days after transplanting maximum bacteria ($72.76 \times 10^6 \text{ cfug}^{-1}$), fungus ($40.56 \times 10^6 \text{ cfug}^{-1}$) and actinomycetes ($58.53 \times 10^6 \text{ cfug}^{-1}$) was recorded in GM₅ media as compared to GM₁ (control) (Table 4). The gel used in the present study had high water absorption during the wetting and it increased survivability of microbiota for longer shelf life. According to previous studies, high porous nature, high surface area, are conducive habitats of hydrogel to increase the micro-organism population size in soil.

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Table: 3 Effect of different growing media on microbiota in growing media at 75 DAYS of transplanting.

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Treatments	Bacteria ($\times 10^6 \text{cfug}^{-1}$)	Fungus ($\times 10^4 \text{cfug}^{-1}$)	Actinomycetes ($\times 10^4 \text{cfug}^{-1}$)
GM ₁	57.93 \pm 1.73 ^D	26.06 \pm 1.86 ^E	43.03 \pm 0.87 ^F
GM ₂	66.13 \pm 0.63 ^{BC}	31.16 \pm 0.84 ^{DE}	47.8 \pm 0.37 ^E
GM ₃	70.3 \pm 0.28 ^{AB}	37.76 \pm 0.93 ^{AB}	56.16 \pm 0.27 ^{AB}
GM ₄	71.36 \pm 0.94 ^{AB}	38.63 \pm 0.73 ^{AB}	57.7 \pm 0.21 ^A
GM ₅	72.76 \pm 1.33 ^A	40.56 \pm 1.02 ^A	58.53 \pm 1.12 ^A
GM ₆	64.83 \pm 0.63 ^C	32.46 \pm 0.67 ^{CD}	49.1 \pm 0.95 ^{DE}
GM ₇	67.83 \pm 1.18 ^{ABC}	35.3 \pm 0.73 ^{ABCD}	51.6 \pm 0.40 ^{CD}
GM ₈	69.6 \pm 0.62 ^{ABC}	36.6 \pm 1.06 ^{ABC}	53.23 \pm 0.66 ^{BC}
GM ₉	72.6 \pm 1.52 ^A	40.13 \pm 1.08 ^A	58.2 \pm 0.4 ^A
GM ₁₀	66.82 \pm 0.60 ^{BC}	34.76 \pm 1.07 ^{BCD}	50.1 \pm 0.73 ^{CDE}

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Table: 4 Effect of hydrogel on microbiota in growing media at 150 DAYS of transplanting.

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Treatments	Bacteria ($\times 10^6 \text{cfug}^{-1}$)	Fungus ($\times 10^4 \text{cfug}^{-1}$)	Actinomycetes ($\times 10^4 \text{cfug}^{-1}$)
GM ₁	61.23 \pm 1.25 ^G	27.1 \pm 0.58 ^D	44.06 \pm 1.2 ^H
GM ₂	66.17 \pm 0.84 ^F	37.3 \pm 0.92 ^C	57.26 \pm 0.62 ^{FG}
GM ₃	73.89 \pm 0.85 ^{ABC}	42.01 \pm 1.07 ^{AB}	63.86 \pm 0.58 ^{CD}
GM ₄	74.93 \pm 0.40 ^{AB}	42.98 \pm 0.36 ^{AB}	64.51 \pm 0.46 ^{BC}
GM ₅	77.44 \pm 0.54 ^A	44.56 \pm 1.07 ^A	69.41 \pm 0.53 ^A
GM ₆	67.26 \pm 0.39 ^{EF}	36.6 \pm 1.35 ^C	54.03 \pm 1.34 ^G
GM ₇	70.63 \pm 0.47 ^{CDE}	40.43 \pm 0.69 ^{ABC}	60.27 \pm 0.69 ^{DEF}
GM ₈	73.34 \pm 0.41 ^{BCD}	40.90 \pm 0.39 ^{ABC}	62.79 \pm 0.60 ^{CDE}
GM ₉	75.74 \pm 1.06 ^{AB}	43.06 \pm 1.39 ^{AB}	68.08 \pm 0.15 ^{AB}
GM ₁₀	69.66 \pm 0.69 ^{DEF}	39.72 \pm 0.82 ^{BC}	58.86 \pm 1.62 ^{EF}

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Conclusion:

The results of the present study indicated that application of hydrogel in growing media i.e. GM₅ [Sand+ vermicompost + hydrogel + Cocopeat +vermiculite and perlite (3: 2.5: 2: 2: 0.5)] had significant effect on physical (pH, EC, Organic carbon), chemical (Bulk density, pore space, water holding capacity) and microbial population parameters at the 75 and 150 days harvesting stage.

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Comment [SR97]: Addition of final recommendation based on the study will improve the transparency in the conclusion.

Comment [SR98]: Please follow the journal guidelines /style

Comment [SR99]: Few references cited in the body of the manuscript are missed in references section.

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Veihmeyer, F., and Hendrickson, A. (1955). Determining water needs for crops from climatic data. *Hilgardia*, **24**(9): 207-233.

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UNDER PEER REVIEW