



Effect of Hydrogel on Physico-Chemical and Microbiota Properties of Potting Media for Roof Top Cultivation of Ridge Gourd

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study was conducted to evaluate the physico-chemical and microbiota properties of growing media containing hydrogel, sand, cocopeat, vermiculite, perlite and vermicompost for cultivation of ridge gourd on rooftop. The result of study revealed that rowing media GM₅ (Sand + vermicompost + hydrogel + cocopeat + vermiculite and perlite with the ratio of 3: 2.5: 2: 2: 0.5

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showed significant effect on Physical properties of the growing media EC (1.85 dS m^{-1}), pH (5.03), total organic carbon (0.843%), physical properties of the growing media bulk density (0.425 g cm^{-3}), total porosity (51%) and maximum level of water holding capacity (66.76 mm). Similarly, 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) and actinomycetes population ($77.44 \times 10^4 \text{ cfu g}^{-1}$), $77.44 \times 10^4 \text{ cfu g}^{-1}$) at 75th day and 150th day was significantly highest in GM₅ sand + vermicompost + hydrogel + cocopeat + vermiculite and perlite (3: 2.5: 2: 2: 0.5) respectively as compared to control. The obtained results claim that sand + vermicompost + hydrogel + cocopeat + vermiculite and perlite act as bio stimulant to nutrient.

Keywords: Hydrogel; pot cultivation; ridge gourd; rooftop cultivation.

1. INTRODUCTION

Any potting media is 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 functional ability and soil organic content that will affect restored vegetation communities during critical stage of development [1,2]. Moreover, activities of soil microbiota 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 unavailable for plants to uptake. Microorganism through numerous mechanisms converts nutrients into available form through solubilization, mineralization, desorption, diffusion, etc [3-5]. Therefore, keeping view the all 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.

2. MATERIALS AND METHODS

2.1 Seed Material and Treatment

The present study was conducted at Department of Horticulture, RCA, MPUAT, Udaipur. Which was laid in EF Polymer bags during February to July 2022 on roof top of building. The variety Arka Prasan was 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 viz. GM₁ [Control: sand + vermicompost + cocopeat + vermiculite and perlite (3: 2.5:2.5: 0.5)], GM₂ [sand + vermicompost + hydrogel + cocopeat + 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)].

2.2 Preparation of Growing Media Samples

5.5 kg media 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).

2.3 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 ($23 \pm 2^\circ\text{C}$), EC was measured by Conductivity bridge meter (Model ORION 105-Range 0 to 199.99 dSm-1 \pm

0.01 given by Wilcox (1950) and Bulk Density and particle density was measured by Core sampler method given by Piper [6], total organic carbon content in media was estimated by the procedure given by Walkely and Black, (1947), water holding capacity, was measured by gravimetric method given by Vihmeyer and Hendrickson (1954). Total porosity (%) of growing media was calculated by the following formula: -

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

2.4 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 from 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 *i.e* bacteria, fungal and actinomycetes population were estimated by standard plate count method for fungal given by Martin [7], while for bacteria and actinomycetes nutrient agar medium was used [8]. Microbial population was calculated and expressed as number of cells/gram growing media.

2.5 Statistical Analysis

All the statical 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 ±.

3. RESULTS AND DISCUSSION

3.1 Effect of Hydrogel on Chemical 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 (1.76 dS/m), pH (6.61), total organic content (0.843 %) as compared to control (Table 1). Researchers have reported

that hydrogels with high water holding capacity can reduce the 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 were reported by Ahrar et al. [9], Montesano et al. [10], and Verma et al. [11].

3.2 Effect of Hydrogel on Physical Properties of Growing Media

The study clearly showed that hydrogel water absorbent was 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), increase porosity (51%) along with water holding capacity (66.76 mm) in growing media (GM₅) as compared to control GM₁ which can be depleted in Table 2. Obtained results are in agreement with the findings of Devi and Gaba [12], in which hydrogel application leads 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 sulphonic group. Therefore, it evident from the presented data that hydrogel in growing media improved physical properties of growing media.

3.3 Effect of Hydrogel on Microbiota at 75 and 150 Days After Transplanting

In present study, significant (p≤0.05) increase in bacteria, fungus and actinomycetes was noticed at 75 days after transplanting and at harvesting. Moreover, maximum population of bacteria (72.76 x10⁶cfug⁻¹), fungus (40.56 x10⁴cfug⁻¹)and actinomycetes (77.44 x10⁴cfug⁻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 (77.44 x10⁶cfug⁻¹), fungus (44.56 x10⁶cfug⁻¹) and actinomycetes (69.41 x10⁶cfug⁻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 conductive habitats of hydrogel to increase the micro-organism population size in soil.

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

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}

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

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}

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

Treatments	Bacteria (x10 ⁶ cfug ⁻¹)	Fungus (x10 ⁴ cfug ⁻¹)	Actinomycetes (x10 ⁴ cfug ⁻¹)
GM ₁	57.93±1.73 ^D	26.06±1.86 ^E	43.03±0.87 ^F
GM ₂	66.13±0.63 ^{BC}	31.16±0.84 ^{DE}	47.8±0.37 ^E
GM ₃	70.3±0.28 ^{AB}	37.76±0.93 ^{AB}	56.16±0.27 ^{AB}
GM ₄	71.36±0.94 ^{AB}	38.63±0.73 ^{AB}	57.7±0.21 ^A
GM ₅	72.76±1.33 ^A	40.56±1.02 ^A	58.53±1.12 ^A
GM ₆	64.83±0.63 ^C	32.46±0.67 ^{CD}	49.1±0.95 ^{DE}
GM ₇	67.83±1.18 ^{ABC}	35.3±0.73 ^{ABCD}	51.6±0.40 ^{CD}
GM ₈	69.6±0.62 ^{ABC}	36.6±1.06 ^{ABC}	53.23±0.66 ^{BC}
GM ₉	72.6±1.52 ^A	40.13±1.08 ^A	58.2±0.4 ^A
GM ₁₀	66.82±0.60 ^{BC}	34.76±1.07 ^{BCD}	50.1±0.73 ^{CDE}

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

Treatments	Bacteria (x10 ⁶ cfug ⁻¹)	Fungus (x10 ⁴ cfug ⁻¹)	Actinomycetes (x10 ⁴ cfug ⁻¹)
GM ₁	61.23±1.25 ^G	27.1±0.58 ^D	44.06±1.2 ^H
GM ₂	66.17±0.84 ^F	37.3±0.92 ^C	57.26±0.62 ^{FG}
GM ₃	73.89±0.85 ^{ABC}	42.01±1.07 ^{AB}	63.86±0.58 ^{CD}
GM ₄	74.93±0.40 ^{AB}	42.98±0.36 ^{AB}	64.51±0.46 ^{BC}
GM ₅	77.44±0.54 ^A	44.56±1.07 ^A	69.41±0.53 ^A
GM ₆	67.26±0.39 ^{EF}	36.6±1.35 ^C	54.03±1.34 ^G
GM ₇	70.63±0.47 ^{CDE}	40.43±0.69 ^{ABC}	60.27±0.69 ^{DEF}
GM ₈	73.34±0.41 ^{BCD}	40.90±0.39 ^{ABC}	62.79±0.60 ^{CDE}
GM ₉	75.74±1.06 ^{AB}	43.06±1.39 ^{AB}	68.08±0.15 ^{AB}
GM ₁₀	69.66±0.69 ^{DEF}	39.72±0.82 ^{BC}	58.86±1.62 ^{EF}

4. 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.

CONFERENCE DISCLAIMER

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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