Effect of hydrogel on physico- chemical and microbiota properties of potting media for roof top cultivation of ridge gourd

Abstract

The present study was conductedto evaluate the physico- chemical and microbiota propertiesof growing media containing hydrogel, sand, cocopeat, vermiculite, perlite and vemicompost for cultivation of ridge gourd on rooftop. The result of study revealed thatrowing media GM_5 (Sand + vermicompost + hydrogel + cocopeat + vermiculite and perlite with the ratio of 3: 2.5: 2: 2: 0.5 showed significant effect on Physical properties of the growing mediaEC (1.85 dS m^{-1}), pH (5.03), total organic carbon (0.843%), physical propertiesof the growing mediabulk density (0.425g cm^{-3}), total porosity (51%)andmaximum level of water holding capacity (66.76 mm).Similarly, bacteria population (72.76 (x 10^6cfu g^{-1}), 77.44(x 10^6cfu g^{-1}), fungus population (40.56cfu, 44.56cfu) and actinomycetes population (77.44(x 10^4cfu g^{-1}), 77.44(x 10^4cfu g^{-1}) at 75^{th} day and 150^{th}day was significantly highest in GM_5sand + 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.

Keyword :- Hydrogel, Pot Cultivation, Ridge Gourd, Rooftop Cultivation

Introduction

Any potting mediais 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. Moreover, activities of soil

microbiotacan 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. 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.

Materialsand methods

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. GM_1 [Control: sand + vermicompost + coco-peat + vermiculite and perlite (3: 2.5:2.5: 0.5)], GM_2 [sand + vermicompost + hydrogel + coco-peat + vermiculite and perlite (3: 2.5: 3.5: 0.5: 0.5)],GM_3 [sand+ vermicompost + hydrogel + coco-peat + vermiculite and perlite (3: 2.5: 2.25: 1.75: 0.5)],GM_4 [sand + vermicompost + hydrogel + coco-peat + vermiculite and perlite (3: 2.5: 1.5: 2.5: 0.5)], GM_5 [sand+ vermicompost + hydrogel + coco-peat + vermiculite and perlite (3: 2.5: 2: 2: 0.5)],GM_6 [sand + vermicompost + hydrogel + coco-peat + vermiculite and perlite (3: 2.5: 0.5: 3.5: 0.5)], GM_7 [sand + vermicompost + hydrogel + coco-peat + vermiculite and perlite (3: 2.5: 1: 3: 0.5)], GM_8 [sand + vermicompost + hydrogel + coco-peat + vermiculite and perlite (3: 2.5: 2.5: 1.5: 0.5)], GM_9 [sand + vermicompost + hydrogel + coco-peat + vermiculite and perlite (3: 2.5 :1.75 :2.25 : 0.5)] and GM_{10} [sand + vermicompost + hydrogel + coco-peat + vermiculite and perlite (3: 2.5: 3: 1: 0.5)].

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).

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 ± 2^0C), EC was measured by Conductivity bridge meter (Model ORION 105-Range 0 to 199.99 dSm-1 ± 0.01 given by Wilcox (1950) and Bulk Density and particle density was measured by Core sampler method given by Piper (1950), total organic carbon content in media was estimated by the procedure given by Walkely and Black, (1947), water holding capacity, was measuredby gravimetric method given by Vihmeyer and Hendrickson (1954). Total porosity (%) of growing media 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 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^{o}C. Microbiota *i.e*bacteria, fungal and actinomycetes population were estimated by standard plate count method for fungal given by Martin, (1950) while for bacteria and actinomycetesnutrient agar medium was used (Allen, 1959). Microbial population was calculated and expressed as number of cells/gram growing media

Statistical Analysis

All thestatical 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 ±.

Results and Discussion

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 GM_5 [sand+ vermicompost + hydrogel + cocopeat +vermiculite and perlite (3: 2.5: 2: 2: 0.5)] significantly affect EC (1.76dS/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.* (2009), Montesano *et al.* (2015), and Varma *et al.* (2019)

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}

Effect of hydrogel on physical properties of growing media

The study clearly showed that hydrogel water absorbentwassignificantly influenced in GM_5 [sand+ vermicompost + hydrogel + cocopeat +vermiculite and perlite (3: 2.5: 2: 2: 0.5)]. Moreover, analysis of variance showed that hydrogel application reduced $0.425 g/cm^3$ (Bulk Density),increase porosity (51%) along withwater holding capacity(66.76 mm)in growing media (GM_5) as compared to control GM_1which can be depleted in Table 2. Obtained results are in agreement with the findings ofDevi and gaba(2019), 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.

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}

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 actinomyceteswas noticed at 75 days after transplantingand at harvesting. Moreover, maximum population ofbacteria (72.76 $x10^{6}cfug^{-1}$), fungus (40.56 $x10^{4}cfug^{-1}$) and actinomycetes ($77.44\ x10^{4}cfug^{-1}$)werenoticedin GM_5 [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 transplantingmaximum bacteria($77.44x10^{6}cfug^{-1}$), fungus ($44.56\ x10^{6}cfug^{-1}$) and actinomycetes ($69.41\ x10^{6}cfug^{-1}$) was recorded in GM_5 media as compared to GM_1(control) (Table 4).Thegel used in the present study had high water absorption during the wetting and it increasedsurvivability of microbiota for longer shelf life. According to previous studies, high porousnature, high surface area, are conductive habitats of hydrogel to increase the micro-organismpopulation size in soil.

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}

Conclusion:

The results of the present study indicated that application of hydrogel in growing media i.e. GM_5 [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 parametersat the 75 and 150 days/harvesting stage.

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