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Standardization of EF polymer as potting media for roof top cultivation of ridge gourd

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Abstract
The present study reports that EF polymer in potting media for rooftop cultivation of ridge gourds bestows myriads effect on growth, yield and quality in ridge gourd plants. Here in media of sand + vermicompost + EF polymer + cocopeat + vermiculite and perlite (3: 2.5: 2: 2: 0.5) had significant effect on vine length (426.5 cm), number of branches per vine (14.66), early flowering (35.6 days), early picking (95 days), duration of flowering (155.67 days), maximum fruit length (22.3 cm), fruit diameter (4.2 cm) and fruit yield (680.66 gm). Similarly, it influences quality parameters such as TSS (4.2°Brix), total sugar (9.15 mg/100 g), protein content (1.39 mg/100 g), vitamin C (4.34 mg/100 g), reducing sugar (6.58 mg/100 g), available of nitrogen (0.86%), phosphorus (0.704%) and potassium (1.87%) in leaf as compare to control. Moreover, EF polymer in potting media act as bio stimulant to stimulate the nitrogen content and influence photosynthetic efficiency in ridge gourd.

Keywords: EF polymer, growth, yield, rooting media, ridge gourd

Introduction
In modern era, Roof top gardening is the most innovative and cost-effective ways of cultivation of horticultural crops. It provides space for food cultivation in highly populated cities. The plants grown on rooftops are vegetables, ornamental, fruits, medicinal plants etc. The purpose of cultivation is obtaining nutritious fresh organic vegetables and creates natural air conditioner inside and nearby building. Green roof technology also reduces air and sound pollution by absorbing them (Dunnet and Kingsbury, 2004; Safayet *et al*., 2017) [5, 14]. As we know that, horticultural food commodities arrive in city from miles away. Therefore, their freshness often reduces. Indiscriminate use of pesticides and preservatives is a matter of concern for public health. There is need for more sensible food systems. Green roofs are attractive, enhancing urban food security and ecologically beneficial (Carney *et al*., 2011) [4]. Generally, growing vegetable on rooftop is done in different types of containers and bags. It is noticed that during summer, high temperature and wind velocity become biggest challenge to cultivate vegetable on rooftop therefore, proper growing media is required to hold moisture and improve nutrient availability within the plants.

Nutrient availability plays pivotal role on production and thus, provision of proper growing media is the pre-requisite for better growth and production of agricultural crops. The growing medium must be porous for root aeration and drainage and thus, capable of water and nutrient retention. Oxygen, of course, is required for all living cells. The coarse textured media often meet these requirements. Good media provides sufficient anchorage or support to the plant, it is the reservoir for nutrients and water holding, allow oxygen to diffuse in the roots and permit gaseous exchange between the roots and atmosphere outside the root substrate (Abad *et al*., 2002) [1].The sand is a primary medium as it is cheap and elementary to obtain supplementing of the sand which is used to form media more porous while the organic matter such as; vermicompost, cocopeat, etc. is added so as to enhance sufficient nutrients for the growth of seedlings. Cocopeat is an agricultural by-product obtained after the extraction of fiber from the coconut husk (Abad *et al*., 2002) [1]. Cocopeat is taken into account as a good growing media component with acceptable pH, electrical conductivity and other chemical attributes (Abad *et al*., 2002) [1]. The coco-peat can hold adequate amount of water, a bit like a sponge.

Vermicompost holds nutrients for a good time while the traditional compost is unable to carry the specified amount of macro and micro nutrients including the vital NPK to plants in less time. Hydrogel polymers are arrangements of organic molecules that exhibit granular when in dry form. When hydrated these are transformed into soft gel (Prevedello and Loyola, 2007) [11] that capable to retain water and plant nutrients and release it to the plants when surrounding soil near the root zone of plants start to dry up. In India, most of the area is located in arid and semi-arid regions. Irrigation water is becoming scarce and the world is looking for water-efficient agriculture. Increasing food demand and declining water resources are challenges for food security (Kreye *et al*., 2009) [8]. So, under such areas, proper management practices should be done in order to conserve moisture and to increase water holding capacity of the soil. Therefore, keeping in view, ridge gourd (*Luffa acutangula*) was grown in ecofriendly bags having media EF polymer, cocopeat, sand, vermicompost, vermiculite and perlite in different ratio so that upshot in growth, yield and quality of ridge gourd fruit can be obtained. Since, In India, area under ridge gourd cultivation is 24800 acre and production is 39 ton per acre.

Materials and Methods

Plant material and growing conditions

Cultivar Arkra Prashan of ridge gourd was purchased from IIHR, Bangalore, India. Seedlings were transplanted in EF bags (12m diameter and 12 cm deep) on the rooftop of Horticulture Department, RCA, Udaipur, Rajasthan, India in month of March to July 2022 having sea level latitude of 5.5 kg Media filled in EF bags comprised of ten treatment combinations and thrice replication considering thirty jute bags having two plants in each. Experimental treatments i.e. GM_1 [Control: sand + vermicompost + coco-peat + vermiculite and perlite (3: 2.5:2.5: 0.5)], GM_2 [Sand + vermicompost + EF polymer + coco-peat + vermiculite and perlite (3: 2.5: 3.5: 0.5: 0.5)], GM_3 [Sand+ vermicompost + EF polymer + coco-peat + vermiculite and perlite (3: 2.5: 2.25: 1.75: 0.5)],GM_4 [Sand + vermicompost + EF polymer + coco-peat + vermiculite and perlite (3: 2.5: 1.5: 2.5: 0.5)], GM_5 [Sand+ vermicompost + EF polymer + coco-peat + vermiculite and perlite (3: 2.5: 2: 2: 0.5)], GM_6 [Sand + vermicompost + EF polymer + coco-peat + vermiculite and perlite (3: 2.5: 0.5: 3.5: 0.5)], GM_7 [Sand + vermicompost + EF polymer + coco-peat + vermiculite and perlite (3: 2.5: 1: 3: 0.5)], GM_8 [Sand + vermicompost + EF polymer + coco-peat + vermiculite and perlite (3: 2.5: 2.5: 1.5: 0.5)], GM_9 [Sand + vermicompost + EF polymer + coco-peat + vermiculite and perlite (3: 2.5 :1.75 :2.25 : 0.5)] and GM_{10} [Sand + vermicompost + EF polymer + coco-peat + vermiculite and perlite (3: 2.5: 3: 1: 0.5)].The statistical analysis was performed with JMP software version 12.

Measurement of plant growth parameters

Vine length (cm) measure with the help of centimeter scale and measured from the base to the apex of main shoot at harvesting stage. Number of branches per vine and number of fruits per vine are counted in the plant. Fruit length measure with the help of centimeter. Fruit diameter measure with the help of Vernier calipers. First flowering counted days after the transplanting of ridge gourd. Duration of flowering counted days to first flowering to the last flowering.

Measurement of quality attributes

Quality parameters like total soluble solid determined with the help of hand refractometer. Reducing sugar content was measured as suggested by Miller (1959) [10] using dinitro salicylic acid. Total sugars were determined calorimetrically by an Optima UV-VIS spectrophotometer (Model SP-3000) using enthrone reagent. Vitamin C determine method was suggested by Ranganna (1986) [12]. Protein measure with the help of method using Nessler's reagent to develop color (Snell and Snell, 1949) [18].

Measurement of yield

The yield per plant determined by help of digital balance and expressed in kg. Single fruit weight and fruit yield per bag measure in the gram.

Measurement of nutrient content in leaf

In experiment Nitrogen content (%) in leaf determined by modified Kjedhal`s method as described by Jackson. Phosphorus content (%) in leaf on dry weight basis biomass was determined by vanadomolybdo-phosphoric acid yellow color method in HNO_3 system as described by Jackson. Potassium content (%) in leaf and vine was extracted by diced digestion and then determined by flame photometer method by Jackson.

Results and Discussion

Effect of growth media on Growth parameters

Growth media having sand+ vermicompost + EF polymer + coco-peat +vermiculite and perlite (3: 2.5: 2: 2: 0.5) significantly increased the vine length (426.5 cm), no of branches per vine (14.66), early flowering (35.6 days), early picking (95 days) and maximum duration of flowering (155.67 days) of ridge gourd respectively, higher than those of the control (Table 1). This is because rooting media has improved the soil physio-chemical properties to ensure efficient water and nutrient uptake and utilization and hydrogel help to moisture conservation and nutrient increasing, resulting in better growth of ridge gourd. Similar research also found in the studies of Akter *et al*. (2021) [2] and Verma *et al*., (2013) [20]. Malviya *et al*. (2020) [9] revealed that use of coco-peat may be good for improvement of vegetative growth (27.50 maximum branches per plant),

Table 1: Effect of growing media on growth attributes of ridge gourd

Treatment	Vine length (cm)	No of branches per plant	First flowering (days)	Duration of flowering (days)	First picking (days)
GM_1	369.93 ± 1.1^{F}	8.0 ± 0.57^{E}	47.0 ± 0.57^{A}	134.33 ± 1.76^{C}	140.0 ± 3.21^{A}
GM_2	386.33 ± 2.1^{E}	9.33 ± 0.88^{DE}	44.33 ± 0.88^{AB}	146.33 ± 1.2^{B}	125.66 ± 2.91^{B}
GM_3	408.0 ± 3.9^{BC}	12.66 ± 0.33^{ABC}	40.66 ± 0.66^{BCD}	152.0 ± 1.52^{AB}	101.33 ± 1.45^{EF}
GM_4	408.83 ± 3.1^{BC}	13.0 ± 0.57^{AB}	39.33 ± 0.88^{BCD}	152.33 ± 2.02^{AB}	98.0 ± 1.15^{F}
GM_5	426.5 ± 2.8^{A}	14.66 ± 0.88^{A}	35.66 ± 1.45^{D}	155.66 ± 3.17^{A}	93.0 ± 1.52^{F}
GM_6	393.9 ± 2.1^{DE}	9.33 ± 0.33^{DE}	42.33 ± 2.02^{AB}	145.66 ± 1.45^{B}	120.66 ± 0.88^{BC}
GM_7	397.16 ± 1.9^{CDE}	11.0 ± 0.57^{BCD}	41.66 ± 1.20^{ABCD}	151.33 ± 1.20^{AB}	114.0 ± 2.08^{CD}
GM_8	400.96 ± 1.2^{BCD}	11.66 ± 0.33^{BCD}	44.0 ± 1.73^{AB}	149.33 ± 2.02^{AB}	108.0 ± 1.15^{DE}

GM_9	409.2±2.1^{B}	13.66±0.33^{AB}	36.0±1.52^{CD}	154.33±1.85^{AB}	95.66±0.66^{F}
GM_{10}	395.13±2.1^{DE}	10.0±0.57^{CDE}	42.0±0.57^{ABC}	148.66±1.20^{AB}	118.0±1.15^{BC}

Effect of growth media on Yield parameters

Media having ratio (3: 2.5: 2: 2: 0.5) of Sand+ vermicompost + EF polymer + Cocopeat +vermiculite and perlite significantly enhanced the fruit length (22.3 cm), fruit diameter (4.2 cm) and fruit yield per bag (680.66 gm) compared with control plants (table 2). In agreement with earlier findings Malviya *et al*. (2020) [9] reveled that nutrient availability plays pivotal role on production and thus, provision of proper growing media is the pre-requisite for better growth and fruit yield. The growing medium must be porous for root aeration and drainage and thus, capable of water and nutrient retention. The enhanced photosynthetic capacity facilitates the translocation of photo synthetase from leaves to sink fruit thereby enhanced the yield of ridge gourd.

Table 2: Effect of EF polymer on growth and yield attributes of ridge gourd

Treatments	Fruit length (cm)	No of fruit per vine	Fruit diameter (cm)	Single fruit weight (gm)	Fruit yield (gm/per bag)
GM_1	8.0±0.57^{G}	1±0.33^{A}	4.33±0.054^{F}	237.67±12.67^{BC}	237±12.66^{C}
GM_2	13.33±0.88^{F}	1.67±0.33^{A}	4.53±0.015^{DE}	237.67±3.38^{BC}	395.3±377.92^{ABC}
GM_3	19.66±0.33^{ABCD}	1.67±0.33^{A}	4.66±0.015^{ABC}	279.67±5.2^{A}	559.3±10.41^{ABC}
GM_4	20.33±0.88^{ABC}	2.33±0.33^{A}	4.67±0.008^{AB}	277.331.85^{AB}	646.38±9.37^{AB}
GM_5	22.33±0.88^{A}	2.67±0.33^{A}	4.72±0.012^{A}	253.67±6.56^{ABC}	680.66±99.46^{A}
GM_6	16.0±0.57^{EF}	1.33±0.33^{A}	4.49±0.012^{E}	217.33±1.85^{C}	289±70.51^{BC}
GM_7	17.0±0.57^{CDE}	1.67±0.66^{A}	4.59±0.011^{BCDE}	274.0±2.3^{AB}	387.33±111.33^{ABC}
GM_8	18.33±0.33^{BCDE}	1.67±0.33^{A}	4.62±0.026^{ABCD}	275.67±1.76^{AB}	460.33±93.69^{ABC}
GM_9	21.33±0.88^{AB}	1.33±0.33^{A}	4.7±0.005^{A}	243.33±20.73^{ABC}	557.67±49.53^{ABC}
GM_{10}	16.66±0.33^{DEF}	1.67±0.33^{A}	4.55±0.008^{CDE}	255±0.57^{AB}	425±85^{ABC}

Effect of growing media on Quality parameters

Growing media having EF biopolymer improved the quality attributes of ridge gourd. However, GM_5 [Sand+ vermicompost + EF polymer + coco-peat +vermiculite and perlite (3: 2.5: 2: 2: 0.5)]significantly enhanced TSS (4.2°Brix), protein content (1.39 mg/100 g), Vitamin C (4.34 mg/100 g), total sugar (9.15 mg/100 g) and reducing sugar (6.58 mg/100 g) as compared to GM_1 [Control: sand + vermicompost + coco-peat + vermiculite and perlite (3: 2.5:2.5: 0.5)] (Table 3). This could be because vermicompost, cocopeat, hydrogel, perlite, vermiculite and soil might have released macro and micro nutrients, which increases the availability of nutrients to the polybag. The higher nutrient availability enhanced photosynthesis and their translocation to different plant parts resulting into higher concentration of nutrients. Similar research also found in the studies Sreeniwas *et al*. (2000) [16] and Rathod *et al*. (2018) [13] in ridge gourd, Shree *et al*. (2018) [15] in bitter gourd, Singh *et al*. (2017) [17] and Thongney *et al*. (2018) [19] in cucumber, Kasture (2019) [7] in snake gourd and Arain *et al*. (2020) [3] in bottle gourd. Malviya *et al*. (2020) [9] revealed that use of coco-peat may be good for quality (TSS 5.15° Brix, total sugars 3.97%, Vitamin C 26.07 mg/100 g fruit, though it was at par with vermiculite 26.52 mg/100 g) followed by peat and compost.

Table 3: Effect of EF polymer on quality parameters of ridge gourd

Treatments	TSS (Brix)	Protein content (mg/100 g)	Vitamin C (mg/100 g)	Total sugar (mg/100 g)	Reducing sugar (mg/g)
GM_1	3.07±0.04^{D}	1.13±0.01^{F}	3.89±0.049^{G}	5.85±0.06^{C}	4.38±0.10^{H}
GM_2	3.33±0.18^{CD}	1.24±0.01^{E}	4.11±0.017^{EF}	7.78±0.06^{B}	5.36±0.05^{FG}
GM_3	3.83±0.09^{ABC}	1.34±0.01^{BC}	4.22±0.01^{BCD}	8.92±0.03^{A}	6.15±0.01^{C}
GM_4	4.1±0.12^{AB}	1.36±0.003^{AB}	4.26±0.012^{ABC}	8.98±0.04^{A}	6.29±0.02^{BC}
GM_5	4.26±0.06^{A}	1.39±0.005^{A}	4.33±0.012^{A}	9.15±0.01^{A}	6.58±0.012^{A}
GM_6	3.43±0.15^{CD}	1.24±0.005^{E}	4.08±0.015^{F}	6.38±0.19^{C}	5.16±0.02^{G}
GM_7	3.66±0.19^{ABCD}	1.31±0.01^{CD}	4.2±0.018^{BCDE}	8.76±0.052^{A}	5.88±0.054^{D}
GM_8	3.73±0.19^{ABC}	1.29±0.01^{D}	4.18±0.014^{CDEF}	8.7±0.005^{A}	5.63±0.02^{E}
GM_9	4.2±0.06^{A}	1.37±0.003^{AB}	4.29±0.008^{AB}	9.08±0.02^{A}	6.44±0.02^{AB}
GM_{10}	3.53±0.07^{BCD}	1.27±0.006^{DE}	4.14±0.018^{DEF}	7.98±0.29^{B}	5.53±0.06^{EF}

Effect of growing media on nutrient uptake in leaf

Data on available N, P, K in leaf (table 4) reveled that growing media GM_5 [Sand+ vermicompost + EF polymer + coco-peat +vermiculite and perlite (3: 2.5: 2: 2: 0.5)] increased uptake of nitrogen (0.86%), phosphorus (0.704%) and potassium (1.87%) in leaf as compared to GM1 [Control) This could be because vermicompost, cocopeat, EF polymer, perlite, vermiculite and soil might have released macro and micro nutrients, which increases the availability of nutrients to the polybag.

Table 4: Effect of EF polymer on nitrogen, phosphorous, potassium in leaf of ridge gourd

Treatments	Nitrogen (%)	Phosphorus (%)	Potassium (%)
GM_1	0.49±0.01^{D}	0.45±0.01^{C}	1.39±0.14^{D}
GM_2	0.557±0.01^{D}	0.56±0.01^{BC}	1.47±0.01^{CD}
GM_3	0.78±0.012^{AB}	0.645±0.012^{ABC}	1.77±0.01^{AB}
GM_4	0.81±0.01^{A}	0.01±0.678^{AB}	1.81±0.01^{A}

GM_5	0.83 ± 0.007^{A}	0.71 ± 0.01^{AB}	1.87 ± 0.01^{A}
GM_6	0.53 ± 0.014^{D}	0.57 ± 0.01^{BC}	1.37 ± 0.02^{D}
GM_7	0.75 ± 0.002^{ABC}	0.62 ± 0.002^{BC}	1.76 ± 0.01^{AB}
GM_8	0.72 ± 0.121^{BC}	0.83 ± 0.12^{A}	1.67 ± 0.01^{ABC}
GM_9	0.81 ± 0.015^{AB}	0.69 ± 0.02^{AB}	1.83 ± 0.01^{A}
GM_{10}	0.68 ± 0.005^{C}	0.589 ± 0.005^{BC}	1.57 ± 0.01^{BCD}

Conclusion

It is concluded that growing media having EF polymer is capable of more absorption of nutrients and waterthereby, promoting more photosynthetic translocation to ridge gourd fruits. Our results together with earlier findings, suggested that GM_5 [Sand+ vermicompost + EF polymer + coco-peat +vermiculite and perlite (3: 2.5: 2: 2: 0.5)] could be promising growing media for enhancing productivity of ridge gourd on roof top, however, the possible environment impacts on growing media must be considered.

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