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Influence of Cocopeat and Vermicompost on Growth and Yield of Cucumber

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ABSTRACT

The present investigation is aimed to determine the effects of cocopeat and vermicompost on growth and yield of cucumber. Three different fertigation levels, i.e. 120% RDF, 100%RDF and 80% RDF were used as main treatments with three combination of soilless medias, i.e. 100% cocopeat, 100% vermicompost and 50% cocopeat + 50% vermicompost were used as a sub main treatments and replicated thrice with split-plot design in the year 2019 and 2020 under naturally ventilated polyhouse conditions. The results showed that treatment combination 100% RDF and 50% cocopeat + 50% vermicompost led to be optimum crop performance and highest yield. Although the highest rate of fertilizer application showed the highest nutrient content, the growth rate of the plants was not optimum among all the treatment combinations. Incorporation of fertilizer into cocopeat and vermicompost soilless growing media contributed to the maintenance of nutrient availability during the growth period, while excessive use of fertilizer did not enable to increase the yield.

Key words: *Cucumber, Soilless growing media, Fertilizer, Cucumber yield, Cocopeat.*

Introduction

The cucumber (*Cucumis sativus* L) belongs to the Cucurbitaceous family, one of the more important plant families. Cucumber plants are indeterminate in growth, continually producing fruit on new growth, similar to greenhouse tomatoes. Greenhouse cucumbers are more sensitive to low temperatures than tomatoes. Minimum temperatures should not be lower than 18 °C for sustained production. Prolonged temperatures above 35 °C should also be avoided as fruit production and quality are reduced at extremely high temperatures.

India is the world's second-largest producer of vegetables. Cucumber is very important in our daily dietetic supplies. It is cultivated mainly in China, Iran, Russia, Turkey, USA, Mexico, Ukraine and India occupied the 27th rank in the world production of cucumbers. According to the Food and Agriculture Organization Corporate Statistical Database, the estimated total world production for cucumbers in 2017 was 83,753,861 metric tonnes, up 3.9% from 80,616,692 tonnes in 2016. China was by far the major producer, accounting for over 77% of global production at 64,824,643 tonnes.

In India, the area under cucumber cultivation is

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82000 ha. with a total production of 1260 million tonnes. The major Cucumber producing States in the country are Haryana, Karnataka, Madhya Pradesh, Uttar Pradesh, Assam, Andhra Pradesh, Bihar, Jammu and Kashmir, Maharashtra, Telangana and other states. In the state of Rajasthan, cucumber production is 16.64 million tonnes with 2790 ha. area in 2018 (Anonymous, 2018).

Polyhouse farming, as well as other modes of controlled environment cultivation, has been evolved to create favourable microclimates, conducive for crop production, making cultivation possible throughout the year or part of the year as required. Adopting soilless culture in protected cultivation with technical practices like integrated plant protection, fertigation, drip irrigation and climate control ensures better yield and water use efficiency. Therefore, studies over the last few decades have mainly focused on the development and rehabilitation of new or readily available systems especially aiming to provide more water and nutrient saving, increased yield and decreased waste of nutrients. This protected cultivation system can control the growing environment through the management of the amount and composition of nutrient solution, weather factors and the growing medium. Modern systems employ manufactured media such as perlite, rock wool, expanded clay and other materials in the plastic grow bags and containers. Certain organic products, such as coconut coir, rice hulls, sawdust, composted plant material and wood chips, etc. also are used successfully for polyhouse soilless culture of vegetables.

Cocopeat can be useful in soilless cultivation especially in areas facing different growing constraints such as water shortage, low fertility and poor soil drainage, unsuitable soil reaction, soil salinity, pest and other ecological problems. Besides the use of coco peat in agricultural fields or as a water conservator in the dry land, coco peat has gained prominence as a potting medium. Furthermore, its distinct features like water resistance and enhanced aeration enable the usage for various agricultural purposes. Cocopeat is an excellent soil conditioner and is being extensively used as a soilless medium for agro-horticultural purposes such as planting lawns, parks and gardens, golf courses and planting vegetable gardens. The application of coco peat in the soil helps in improving the structure and other physical and chemical properties of the soil. Because of its sponge-like structure, coco peat helps to improve aeration and retain water in the root zone.

Neethi *et al*., (2006) and Rajarathnam *et al.* (2007) coir pith is a by-product of the coir industry, producing more than 7.5 million tonnes annually in India. It can be used as fuel in loose form or briquettes. This study investigates different physical properties of coir pith concerning its moisture content (10.1 to 60.2% w.b.) and particle size (0.098 to 0.925 mm). Porosity and particle density varied from 0.623 to 0.862 and from 0.939 to 0.605 gm/cc respectively. Bulk density and static coefficient of friction against mild steel were in the range of 0.097 to 0.341 gm/cc and 0.5043 to 0.6332 respectively. Models were developed for the above properties.

Gruda (2009) revealed that soilless culture is based on environmentally friendly technology resulting in higher yields and that too without quality deterioration. Adoption of cultural management to the specific cultural system, as well as crop demand, can further result in the improvement of quality and quantity of horticultural products.

Hussain *et al*. (2014) and Sharkawi *et al*. (2014), Barrett *et al*. (2016) and Saurabh *et al*. (2019) collected a reviewed on effect of different soil less growing media on vegetable production. They revealed that Soilless culture is a method of artificially supporting plants and serving as a reservoir for nutrients and water. It is now commonly utilized in research institutes as a method for researching plant nutrition. Tomatoes, capsicum, cucumber, peas, and cauliflower are among the crops produced in soil. Substrates used in soilless culture must be low-cost, disease-free, and conveniently accessible, as well as capable of providing sufficient nutrients to agricultural plants growing in them. Vegetables produced in cultivation regularly have outstanding quality, high yield, quicker harvest, and great nutritive values. However, in the case of undeveloped nations, there is a lack of familiarity and a poor transmission of existing technology. It's indeed critical to supply scientifically proven technology to gardeners and generate wider understanding in prospective regions at the global level in order to popularize soilless gardening

Soilless cultivation generally improves water use efficiency (WUE) and reduces the demand for water. Protected cultivation using soilless culture tremendously reduces the water use and improves the WUE. Particularly coco peat-based media has good water holding capacity and a high volume of expansion and there is a scope to study the irrigation scheduling on coco peat-based media so that the frequency of irrigation and quantity of water applied can be reduced compared to conventional methods. Generally, studies on coco peat-based media stress on applying irrigation the same amount as in soil. There have been no reported studies on the irrigation scheduling in coco peat to find out whether a lesser amount of application or less frequency of irrigation can sustain the crop without affecting yield. Therefore, the specific investigation was conducted to study the effect of growing medias on Cucumber yield.

Materials and Methods

The present experiment was conducted during the July to November of the years 2019-20 and 2020-21 respectively, at Technology Park, College of Technology and Engineering, MPUAT, Udaipur. The study area is situated at $75^0 42'$ E longitude and $24^0 35'$ N latitude and an elevation of 582.17 meters above MSL. Udaipur comes under sub-humid agro-climatic region, receives an average annual rainfall of 654 mm, most of the received during the period of July to September. May is the hottest and December is the coolest month of the year. The average weekly maximum temperature goes as high as 46 °C during summer and minimum as low as 5 °C during winter months. The atmospheric humidity is high from June to October. The meteorological data of significant weather parameters has been collected on a daily basis from the meteorological observatory of Department of Soil and Water Engineering, CTAE, Udaipur. The meteorological data for a period of 5 years (2014-2018) were used in this study. The meteorological data include daily parameters (i.e. maximum temperature (T_{max}) and minimum temperature (T_{min}), maximum relative humidity (RH_{max}), minimum relative humidity (RH_{min}), wind speed at the height of 3 m, Pan Evaporation, and sunshine hours). Dry and wet bulb thermometers located inside the polyhouse was used to determine relative humidity values inside the polyhouse.

In the present experiment the soilless growing medias *i.e.* Cocopeat and Vermicompost are chosen because of cocopeat and vermicompost can be used in soilless cultivation especially in areas facing different growing constraints such as water shortage, low fertility and poor soil drainage, unsuitable soil reaction, soil salinity, pest and other ecological problems. Besides the use of cocopeat in agricultural fields or as water conservant in dry land, coirpith has gained prominence as growing medium. Furthermore, its distinct features like water resistance and enhanced aeration enables the usage for various agricultural purposes.

The experiment was conducted in a split-plot design with three replications R1, R2 and R3. Fertigation is the main plot and different soilless growing media is the sub-main plot under naturally ventilated polyhouse. Fertigation includes three levels i.e., F1-120% RDF, F2-100% RDF and F3-80% RDF of complete nutrient solution required under optimal microclimate conditions. Three soilless media combinations are used i.e., S1-100% coco peat, S2-100% vermicompost and S3-50% coco peat: 50% vermicompost.

The irrigation applied to the plant was in a low rate than the actual requirement in order to reduce drainage as no drainage collection and recirculation was done. At the initial stage the crop was irrigated twice daily with application rate of 0.25 litre in the morning and 0.25 litre in the evening. During the development stage the plant requires more water than initial stage. So the water applied was increased from 0.5 to 1 l/day/plant. After mid stage water application rate was increased to 1.5 l/day/plant as the water uptake by plants increases during

Table 1. Physical properties of cocopeat, vermicompost and combination of cocopeat + vermicompost

Property	Cocopeat	Vermicompost	Cocopeat + Vermicompost
Bulk density (g/ cm^3)	0.13	1.12	0.75
Particle density (g/cm^3)	0.20	2.20	1.35
volume of expansion	0.39	0.15	0.27
Total porosity (%)	87.50	65.00	72.00
Moisture content (%)	538.78	112.09	204.30
Field capacity (%)	538.78	34.21	204.30
Wilting capacity (%)	123.54	14.00	68.92
Water holding capacity (%)	415.24	20.21	135.38

mid-stage.

Growth and Yield Parameters

Plant Height / Length of the MainVine: The height of the plant from the base level of the shoot to the tip will be measure at 30 days intervals and expressed in centimeters for each treatment.

Number of Leaves: The number of leaves per plant will be recorded at 30 days intervals in selected plants.

Yield Parameters: The yield parameters evaluated for the study will be as follows.

Fruit Yield per Plant (kg): The weight of mature fruits harvested from each picking will be recorded until the final harvest and total yield of fruits per plant will calculate in kilograms.

Average Fruit Weight (gm): The weight of mature fruits harvested from each picking in each plant in each replication will be recorded until the final harvest and average weight of will be compute.

Fruit Yield (t/ha): The weight of mature fruits harvested from each picking in each plant in each replication will be recorded until the final harvest and the total yield of fruits per hectare will be computed and expressed in tons per hectare.

Results and Discussion

Plant height/ Length of main vine (cm)

The individual as well as pooled statistical results of plant height as influenced by different fertigation levels s and growing media levels.

Effect of soilless media: Results showed in Table 3. is plant height/vine length was significantly influenced by different growing medias in first and second year as well as under pooled results. Significantly higher mean vine length of 291.04 and 321.64 cm was recorded under S_3 (50% Cocopeat + 50% Vermicompost on w/w basis) treatment during 2019 and 2020 years respectively. Under pooled results significantly higher vine length 306.04 cm was observed under S_3 treatment, however it was found that S_3 treatment shows the dominance in the growth of the plant. The minimum vine length was recorded in S_1 (Cocopeat – 100%) at all stages of the crop during 2019, 2020 and pooled results. This was due to sufficient nutrient supply favouring the intending rapid cell division and cell elongation which in turn resulted in higher plant height under S_3 irrigation treatment. Similar results was reported byNikolaou *et al.*, (2017) maximum height through fertigation.

In the present investigation, the maximum vine length was recorded with the application of 120% water soluble fertilizer + fertigation of micronutrients, which could be attributed to the optimal availability of macro and micronutrients. Pafli (1965) opined that nitrogen, being the chief constituent of chlorophyll is accelerated through increased supply of nitrogen at required doses to the plants at appropriate time. Thus, fertigation deserves one of the

Table 2. Chemical properties of cocopeat and vermicompost

Property	Cocopeat	Vermicompost	Cocopeat + Vermicompost
pH	6.20	7.16	6.82
EC (ds/m)	1.90	1.42	2.85
N (%)	0.52	1.66	2.20
P (P_2O_5) (kg/ha)	0.80	1.25	0.72
K (K_2O) (kg/ha)	1.28	12.80	8.50
Organic Carbon (%)	29.00	17.30	21.58

Table 3. Effectofdifferent soilless media on Plant height/ length of main vine at harvest

Plant height/	2019				2020				Pooled			
length of main vine	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean
S1	210.7	200.7	190.0	200.49	296.08	275.00	182.37	251.15	253.39	237.86	186.20	225.82
S2	249.3	271.8	216.3	245.80	346.50	302.33	211.03	286.62	297.90	287.09	213.64	266.21
S3	311.1	328.2	233.8	291.04	384.25	333.08	247.58	321.64	347.67	330.66	240.69	306.34
Mean	257.03	266.94	213.36		342.28	303.47	213.66		299.65	285.20	213.51	
	SEm±		CD (P=0.05)		SEm±		CD (P=0.05)		SEm±		CD (P=0.05)	
Soilless Media	1.439		4.434		2.681		8.262		0.817		2.293	

prime aspects that contribute to increased vine length. Cucumber, a vine vegetable crop responded to synthesis of desirable hormones such as auxin which would have encouraged the apical growth that ultimately could have resulted in better vine length in cucumber. Sufficient supply of required nutrients, the production of auxin might have triggered which consequently would have showed stimulatory action in terms of cell elongation, and resulting in increased vine length.

Number of leaves

Effect of soilless media

Results showed in Table 4. from the results observed that number of leaves was significantly influenced by different growing medias in first and second year as well as under pooled results. Significantly maximum number of leaves of 12.67,23.17,33.94 and 43.36 and 13.19, 24.64, 31.25 and 39.62 was recorded at 30, 60, 90 DAS and at harvest respectively, under S_3 (50% Cocopeat + 50% Vermicompost on w/w basis) treatment during 2019 and 2020 years. Under pooled results significantly higher number of leaves 41.49 was observed under S_3 treatment, however it was found that S_3 treatment shows the dominance in the growth of the plant. The minimum number of leaves was recorded in S_1 (Cocopeat – 100%) at all stages of the crop during 2019, 2020 and pooled results. Similarly Eifediyi and Remison (2010) reported the growing media and fertigation increases the number of leaves.

Fruit yield per plant (kg)

Effect of soilless media: The data obtained on fruit yield per plant as influenced by different growing media treatments were recorded. Results showed in Table 5. from the results observed that fruit yield per plant was significantly influenced by different growing medias in both the years and pooled results as well. Significantly maximum fruit yield per plant was observed in S_3 (50% Cocopeat + 50% Vermicompost on w/w basis) with 3.61, 4.07 and 3.84 kg during 2019, 2020 and pooled results. The minimum fruit yield per plant are 2.43, 2.07 and 2.25 during 2019, 2020 and pooled results under S_1 (100% Cocopeat) treatment. There is a significant difference statistically during 2019, 2020 and in pooled results between the treatment mean. These results were in accordance with the findings of Zhang *et al*. (2011) showed that the cucumber fruit yield increased with the improvement of N application through irrigation water. Irrigation water increased yields by increasing the mean weight of the fruits, and also by increasing fruit number.

Table 4. Effect of different soilless media on number of leaves at harvest

Number of leaves	2019				2020				Pooled			
	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean
S_1	33.2	34.5	26.0	31.24	35.75	35.17	31.25	34.06	34.47	34.84	28.64	32.65
S_2	40.4	42.4	30.9	37.88	41.08	41.17	34.50	38.92	40.73	41.78	32.69	38.40
S_3	43.7	44.8	30.3	39.62	45.25	46.25	38.42	43.31	44.49	45.53	34.37	41.46
Mean	39.10	40.57	29.07		40.69	40.86	34.72		39.90	40.71	31.90	
	SEm±		CD (P=0.05)		SEm±		CD (P=0.05)		SEm±		CD (P=0.05)	
Soilless Media	0.527		1.624		0.309		0.953		0.267		0.750	

Table 5. Effectofdifferent soilless media on fruit yield per plant (kg)

	Fruit yield per plant (kg)											
	2019				2020				Pooled			
	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean
S_1	2.77	2.40	2.13	2.43	2.29	2.32	1.61	2.07	2.53	2.36	1.87	2.25
S_2	2.95	3.21	2.70	2.95	3.57	3.96	2.49	3.34	3.26	3.58	2.60	3.15
S_3	3.69	3.99	3.14	3.61	4.38	4.89	2.94	4.07	4.03	4.44	3.04	3.84
Mean	3.13	3.20	2.66		3.41	3.72	2.34		3.27	3.46	2.50	
		SEm±		CD (P=0.05)		SEm±		CD (P=0.05)		SEm±		CD (P=0.05)
Soilless Media		0.07		0.20		0.05		0.14		0.03		0.09

Average fruit weight (g)

Effect of soilless media: The data obtained on fruit weight as influenced by different growing media treatments were recorded. Results showed in Table 6. from the results observed that fruit weight was significantly influenced by different growing medias in both the years and pooled results as well. Significantly mean maximum fruit weight was observed in S_3 (50% Cocopeat + 50% Vermicompost on w/w basis) with 177.42, 184 and 180.71 g during 2019, 2020 and pooled results. The minimum fruit weights are 116.56, 144.64 and 130.60 g during 2019, 2020 and pooled results under S_1 (100% Cocopeat) treatment. There is a significant difference statistically during 2019, 2020 and in pooled results as well between the treatment means. S_3 treatment is shown the superiority throughout the seasons, this may be due to the sufficient nutrient supply. The results showed that application of 120% RDF recorded the highest fruit weight, but 100% RDF also statistically on par with F_1. The higher fertigation level results in higher average single fruit weight, which directly influences the yield per hectare. It may probably be attributed to the nature of interaction of physiological and growth parameters by way of increased dry matter production which were in conformity with Paul *et al*. (2013) in capsicum.

Fruit yield (t/ha)

Effect of soilless media: The data obtained on fruit yield as influenced by different growing media treatments were recorded. Results showed in Table 4 and Fig. 4, from the results observed that fruit yield was significantly influenced by different growing medias in both the years and pooled results as well. Significantly maximum fruit yield was observed in S_3 (50% Cocopeat + 50% Vermicompost on w/w basis) with 54.02, 60.96 and 57.49 t/ha during 2019, 2020 and pooled results. The minimum fruit yield per square meterare 36.47, 30.98 and 33.72 t/ha during 2019, 2020 and pooled results under S_1 (100% Cocopeat) treatment. There is a significant difference statistically during 2019, 2020 and in pooled results between the treatment means.

The interaction effect between fertigation and growing media (F X S) was found, there is a significant difference within treatment means during 2019, 2020 and pooled results shown in Table 4. The results showed that application of 100% RDF recorded the highest fruit yield per plant with the combina-

Table 6. Effect of different soilless media on Average fruit weight (g)

	Average fruit weight (g)											
	2019				2020				Pooled			
	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean
S_1	123.71	115.04	110.93	116.56	155.23	150.70	128.00	144.64	139.47	132.87	119.46	130.60
S_2	160.74	154.68	136.04	150.48	168.62	176.46	174.15	173.07	164.68	165.57	155.09	161.78
S_3	186.77	188.53	156.96	177.42	187.10	191.13	173.77	184.00	186.93	189.83	165.36	180.71
Mean	157.07	152.75	134.64		170.31	172.76	158.64		163.69	162.75	146.64	
		SEm±		CD (P=0.05)		SEm±		CD (P=0.05)		SEm±		CD (P=0.05)
Soilless Media		2.13		6.55		2.20		6.77		1.11		3.11

Table 7. Effectofdifferent soilless media on fruit yield (t/ha)

	Fruit yield (t/ha)											
	2019				2020				Pooled			
	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean
S_1	41.52	35.94	31.93	36.47	34.19	34.66	24.08	30.98	37.86	35.30	28.01	33.72
S_2	44.15	48.15	40.50	44.27	53.46	59.21	38.09	50.25	48.80	53.68	39.29	47.26
S_3	55.25	59.80	47.01	54.02	65.55	73.32	44.00	60.96	60.40	66.56	45.51	57.49
Mean	46.97	47.97	39.82		51.07	55.73	35.39		49.02	51.85	37.60	
		SEm±		CD (P=0.05)		SEm±		CD (P=0.05)		SEm±		CD (P=0.05)
Soilless Media		0.95		2.93		0.81		2.49		0.49		1.37

tion of S_3 (50% Cocopeat + 50% Vermicompost). The highest fruit yield under fertigation treatment could be due to continuous supply of NPK as reported by Fleafel *et al.* (2014) and Lata *et al.* (2018).

Conclusion

Growth and yield of cucumbers like maximum vine length (328.20 cm in F_2S_3 during 2019 and 384.30 cm in F_1S_3 during 2020), average number of leaves per plant (44.80 DAS and 46.25 DAS in F_2S_3 during 2019 and 2020), average fruit weight (157.07 g in F_1S_3 during 2019 and 172.76 g in F_2S_3 during 2020), fruit yield per plant (3.20 kg and 3.72 kg in F_2S_3 during 2019 and 2020) and fruit yield (59.80 t/ha and 73.32 t/ha in F_2S_3 during 2019 and 2020). Significantly highest yield was observed with the treatment combination of 100% RDF and 50% cocopeat + 50% vermicompost.

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