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Study of soilless cultivation of cucumber in polycarbonate greenhouse

YH Modhvadiya and Dr. MV Jalu

Abstract
The experiment was laid out in large plot technique design with five replications comprising of total five treatment combinations. The five treatment consists of T_1: Soilless Media (Coco-peat grow bag), T_2: Soil Media, T_3: Coco-peat + Soil (1:1), T_4: Vermicompost + Soil (1:1), T_5: Coco-peat + Vermicompost + Soil (1:1:1). Healthy seeds were sown on grow bag and soil bed at 0.60 m × 0.30 m spacing, during the month of March, 2021. Irrigation was supplied to the crop through drip irrigation system and. Cultivation practice was carried out as per recommendation.

The daily environmental data *i.e.* air temperature, RH, PAR, soil temperature and soil moisture were recorded at every three hours of interval and computed weekly and monthly average for analysis. The influence of these factors on summer cucumber was analyzed in terms of vine length, no. of fruits per vine, weight of fruit per vine, dimension of fruit (length and diameter) and crop yield per treatment. Five plants from each treatment were selected for each replications and an economic analysis was also done to determine the financial viability of the structure as well as different treatment cost.

Total thirteen harvesting of cucumber fruits were done during entire crop season and highest crop yield was 93.38 t/ha observed in treatment T_4 (Soilless media having vermicompost + soil) as well as other crop parameters *i.e.* vine length, no. of fruits per vine, weight of fruit per vine, length of fruit and diameter of fruit was observed as 248 cm, 11.68 nos./plant, 2561.52 g, 174.62 mm and 48.55 mm, respectively.

The highest net profit and BCR was found ₹ 256.75/m^2 and 2.57 for treatment T_4 and lowest payback period was found 3.11 years also for the treatment T_4. It was concluded that, in order to obtain higher marketable yield and net return of cucumber during off-season in polycarbonate fan and pad greenhouse with soilless media having vermicompost + soil could be the best option under agro climatic conditions of Saurashtra region of Gujarat, India.

Keywords: Polycarbonate greenhouse, cucumber, soilless media, cocopeat, vermicompost

Introduction
Vegetable crops are becoming an important alternative in the diversification of agriculture and playing a significant role in food, nutrition and health security of the ever-growing population of India. Cucumber (*Cucumis sativus* L.) is a widely cultivated plant belonging to the family Cucurbitaceae. It is a creeping vine that bears cucumiform fruits that are used as vegetables. Cucumbers are originated in India. It is a climbing plant which is used as summer vegetable throughout in India.

It is rich in Vitamin K (21.3%), Vitamin C (4.8%), Vitamin B5 (2.7%), Vitamin A (2%), and minerals like Molybdenum (6.9%), Manganese (4%), Magnesium (3.3%), Potassium (4.3%) per 100 g fresh weight.

The present production is not sufficient to meet the requirement in which vegetable cultivation practices have generally been restricted to regional and seasonal needs. In several parts of country, the soil are fertile but extreme temperature and climatic conditions do not allow year round outdoor vegetable cultivation. As a result, most of these vegetables are severely damaged. The target can be achieved by bringing additional area under vegetable crops, using hybrid seeds, improved agro techniques and perfection and promotion of protected cultivation of vegetables. As majority of the population in India is vegetarian so, there is a strong need to increase the production of vegetables.

- High annual precipitation with irregular distribution or high precipitation in short periods of time.
- Shortage or lack of water in dry seasons.
- Strong erosion due to high rain intensities
- Plant protection is more difficult when pesticides are washed off the plants by heavy rain.

- Working conditions are difficult in open field.

Greenhouse are structures covered with transparent material such as polythene or glass. The covering acts like a selective radiation filter and allows short wave length solar radiation to pass but traps the long wave length radiation. The long wave radiations emitted by the plants and objects in the greenhouse cannot pass through the covering material owing to its lesser transparency for it. This results into rising of the temperature inside the greenhouse due to trapped solar energy inside the greenhouse (greenhouse effect). The climatic control in the green house can be used for altering the physiological conditions of the plants. Closing of the greenhouse during the night, rise in CO_2 level resulting from respiration by the plants that in turn is used for photosynthesis by the plants during the early morning hours of the following day.

The rise in temperature, relative humidity, CO_2 level and enriched nutrition under protected conditions of the greenhouse is accountable for fast growth and increased production. The temperature in greenhouse can be brought down by providing cooling through ventilation, fogging or operating the fan pad system. This facilitates round the year production of desired vegetable crops and exploits their maximum yield potential. Higher plant density by closer planting and higher number of fruiting branches per unit area under protected cultivation increases the yield tremendously. In India Greenhouse/polyhouse is mainly classified in three different categories:

Low cost polyhouse is made of 200 microns transparent polythene sheet supported on bamboos with jute sutli (ropes) and nails. It is used for protecting the crop from high rainfall. The temperature within polyhouse increases by 6-10 °C more than outside. In UV stabilized plastic film covered pipe framed polyhouse, the day temperature is higher than the outside. The solar radiation entering the polyhouse is 30-40% lower than that reaching the soil surface outside. During summers, the sides can be opened to moderate the temperature within the greenhouse in day time.

A medium-cost greenhouse having slightly higher cost is Quonset shaped that can be made with GI pipe (class B) of 15 mm diameter. The structure is covered with single layer of UV-stabilized polythene of 200-micron thickness. It can be naturally ventilated by providing openable windows along the sides and the roof or else exhaust fans may be used for ventilation. The fan pad system can also be used for humidifying the polyhouse, thus lowering the temperature. The life span of frame and covering material is about 10 years and 3 years, respectively.

It is constructed with iron/aluminum structure (frame) having dome or cone shaped design. Temperature, humidity and the light are automatically controlled as per crop requirement. Floor and a part of side walls are made of concrete. It is highly durable but the cost is about 5-6 times. It requires qualified operator, proper maintenance, care and precautions during operation.

The forced ventilation by fan-pad method is an expensive method for cooling of greenhouse. Fan-pad system required investment for ventilation. But at places having temperate climate, as the temperature in summer is very high thus, the inside temperature of greenhouse is maintained by such methods.

Review of literature

Resh (2001) [6] mentioned that rock wool is an inert fibrous material produced from a mix of volcanic rock, limestone and coke, melted at 1500 to 2000 °C. It is extruded as fine threads and pressed into loosely woven sheets Surface tension is reduced by the addition of a phenol resin during cooling. While the composition of rock wool varies slightly from one manufacture to another, it basically consists of silica dioxide (45%), aluminum oxide (15%), calcium oxide (15%), magnesium oxide (10%), iron oxide (10%) and other oxides (5%). Rock wool is slightly alkaline, but it is inert and biologically non-degradable. It has good water-holding capacity, with about 95% pore space. All fertilizers must be added to the irrigation water for plant growth Rock wool is about an 80% water holding capacity. The pH of rock wool is between 7 and 8.5. Since it has no buffering capacity, the pH can easily be reduced to optimal levels of 6.0 to 6.5. Rock wool culture is generally an open, non-recycling hydroponic system, with nutrients fed to the base of each plant with an emitter and drip line.

Ghehsareh (2013) [2] studied the effect of date palm wastes and rice hull mixed with soil on growth and yield of cucumber in greenhouse culture. The treatments were pure palm peat, pure rice hull, soil + 5% (weight) palm peat, soil + 5% (weight) rice hull, soil + 5% (weight) palm peat + 5% (weight) rice hull and pure soil. The highest and lowest amount of fruit yield was related to palm waste and S + Pa 5% + Rh 5% were 3.67 kg and 1.04 kg, respectively. The highest plant height, stem diameter and shoot dry mass related to palm waste media that had 328.1 cm, 1.8 cm and 88.4 g, respectively.

Mazahreh *et al.* (2015) [5] assessed an experiment on the effect of different growing media on cucumber production and water productivity in soilless culture under UAE conditions. The effects of four different media based on 1:0, 1:1, and 1:2, v/v of perlite and coco-peat as well as cocopeat growbags were evaluated on quantity and quality of cucumber yields in soilless culture. The results revealed that Perlite/Coco-peat (P/C) substrates in 1:0 ratio (v/v) produced the highest-class A yield with 87.6 tones/ha, while coco- peat growbag showed the lowest yield (46 tones/ha). In terms of water productivity, the produced cucumber yields had better conditions in perlite with the highest net profit and water productivity values. In addition, the results indicated that by mixing coco-peat with perlite in 1:1 ratio, the yield significantly increased by 82% compare to cocopeat growbags.

Al-Far *et al.* (2019) [1] assessed the evaluation of different soilless media on growth, quality, and yield of cucumber (*Cucumis sativus* L.) grown under greenhouse conditions. Different soilless media such as T: Tuff 100%; TP: Tuff + Perlite 50% each; TPS: Tuff + Perlite + Sawdust 33% each; and TS: Tuff + Sawdust 50% were used in the experiment. This study concluded that using TS media for seedless cultivar is the best successful growing soilless media as well as the cheapest compared to other solid media used and the TPS media showed minimum growth and low yield in both cucumber cultivars. The highest plant height was scored for seedless cultivars grown in media TP (229.5 cm), compared to the lowest value (204.8 cm) grown in media TS.

Koravan *et al.* (2013) [3] studied that greenhouse production of tomato under the climatic conditions in Northern Thailand can reduce the occurrence of pest and insects thus, the need for the application of pesticides are reduced. Temperature and humidity levels inside the greenhouse seem to be the major leading problem to lower yields.

Singh *et al.* (2015) [7] observed that India produces 283 million tones of horticulture production and has surpassed the food grain production in the country. Productivity increases by about 34% in 2004-05 to 2014-15. Horticulture production is about 30% of agriculture GDP using only 17% of land area. With the advance protected cultivation technology, high valued crops production can be increased.

Kumar *et al.* (2017) [4] reported that protected cultivation of vegetable crops was an advantageous technology for farming community because it's cost effective technique. Vegetables grown by this method was safe to consume due to less use of chemicals. This technique also provides congenial environment to off season cultivation as well as high and quality production. Therefore, increasing demand of vegetables for growing population would be fulfilled by protected structure technology.

Materials and Methods

The methodology adopted to deal with the structure, parameters and replications considered for the experimental design and recording of data for experimental study. Procedure and instrumentation considered for conducting experiment and the methodology adopted for data analysis.

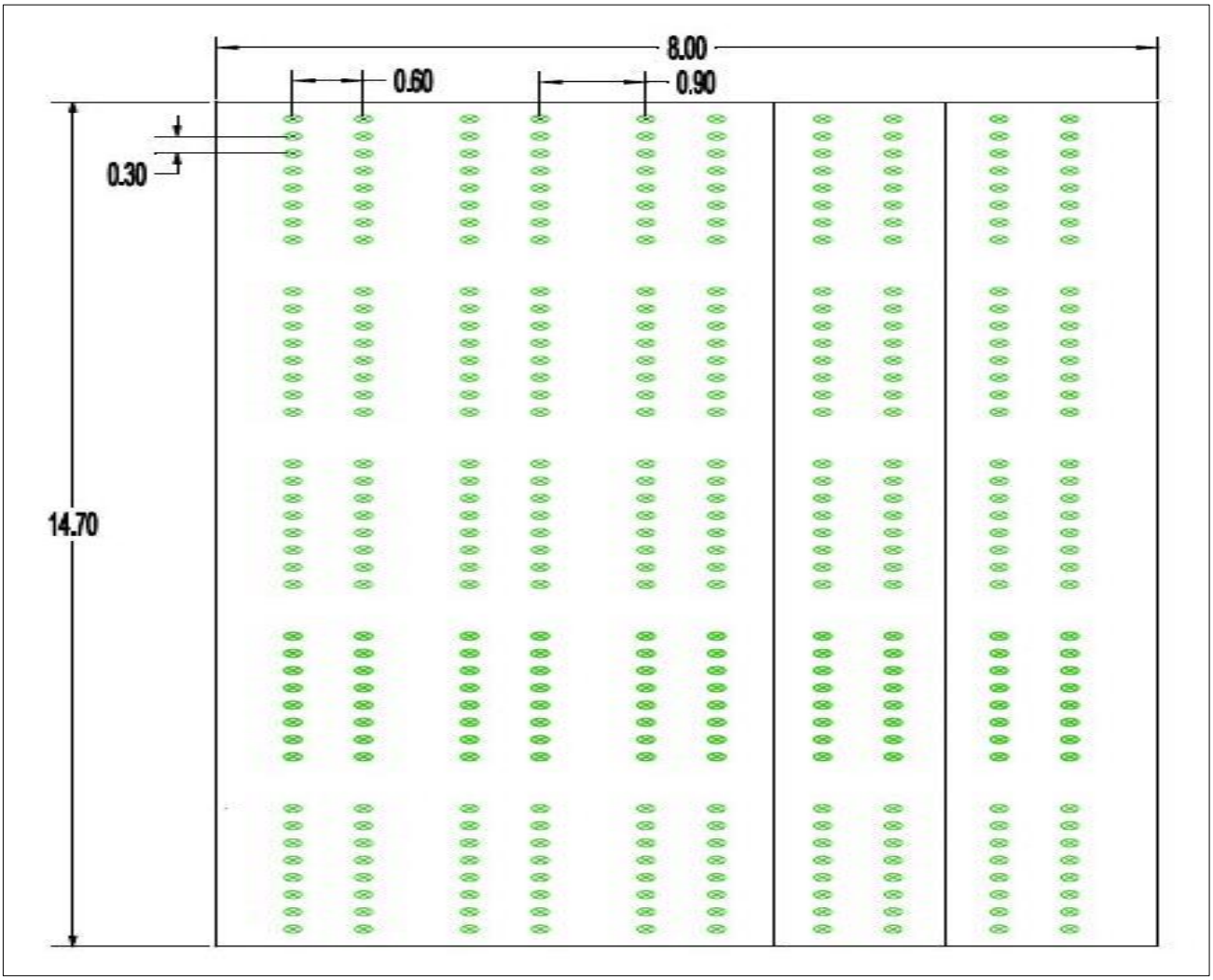
Experimental Details

The experiment was conducted on one variety of crop and five root media for cultivation of cucumber in polycarbonate fan pad greenhouse. Details of which are given below:

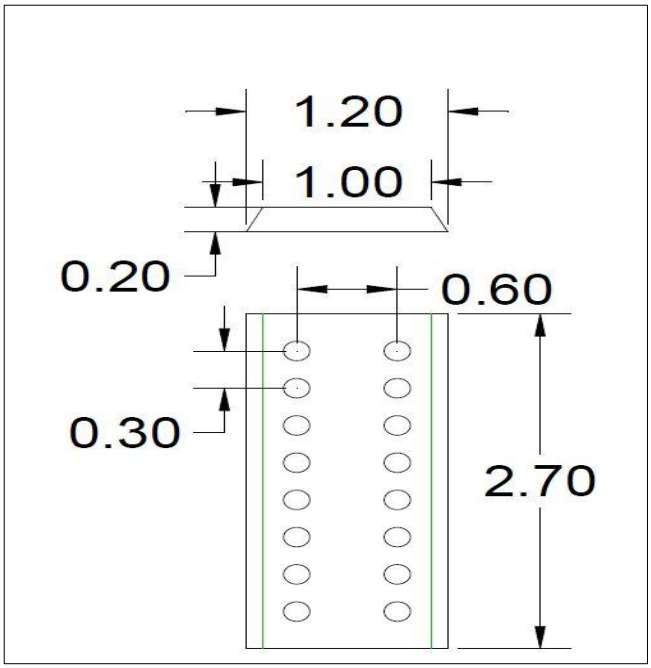
1. Crop: Cucumber
2. Variety: V: Yuksel Tohum RICA++ F1
3. Treatment details: Single factor

Media: T_1: Soilless Media (Coco-peat grow bag)
T_2: Soil Media
T_3: Coco-peat + Soil (1:1)
T_4: Vermicompost + Soil (1:1)
T_5: Coco-peat + Vermicompost + Soil (1:1:1)
4. Plot Size: 2.70 m × 1.50 m
5. Repetition: Five

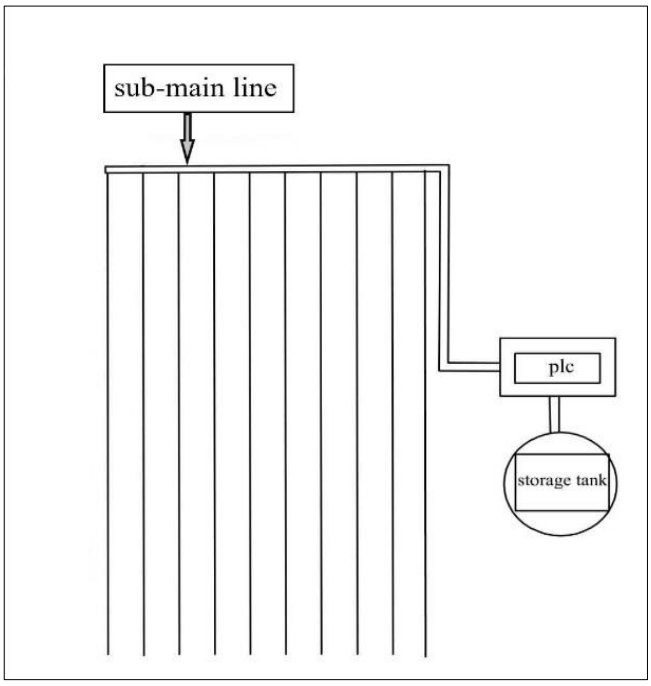
Experimental Layout



Field layout of experiment



Top view of treatment



Irrigation Layout

Bed Size

a) Top width: 0.80 m
b) Bottom width: 1.00 m
c) Height: 0.20 m

Open Top Grow Bag

Size: (H×W×L): 25cm×20cm×20cm

Materials required for irrigation

1. **Water source:** The water tank was used as a water source.
2. **Pumping system:** The electric motor of 0.5 HP × single phase was used for pumping the water from the tank.
3. **Bypass assembly:** The bypass assembly of 75 mm was fitted on main line
4. **Pressure gauge:** The pressure gauge of 0 - 4 kg/cm^2 fitted before and after the filter for measuring the operating pressure.
5. **Main line/Sub main line:** The PVC pipe of 25.4 mm × 4 kg/cm^2 was used as main line and 25.4 mm × 4 kg/cm^2 as a sub main line, lateral line was connected with sub main line by grommet and take-off.
6. **Lateral:** Heavy-duty black colored LDPE lateral line of 16 mm × 2.5 kg/cm^2 of 4lph discharge on-line dripper at 0.3 m spacing was used.
7. **Lateral cock:** Lateral cock of (16 mm) was used at the starting of lateral line to control the irrigation water.

Other materials required for the experiment were PVC fittings, flush for main/sub main line, joiner, grommet, start connector, take off, end plug, etc.

Preparation of field

Plots were marked out and 5 beds of 2.70 m length, top width of 1.00 m, bottom width of 1.20 m and height of bed was 0.20 m. The beds were irrigated by drip irrigation system.

Preparation of soilless media and grow bags

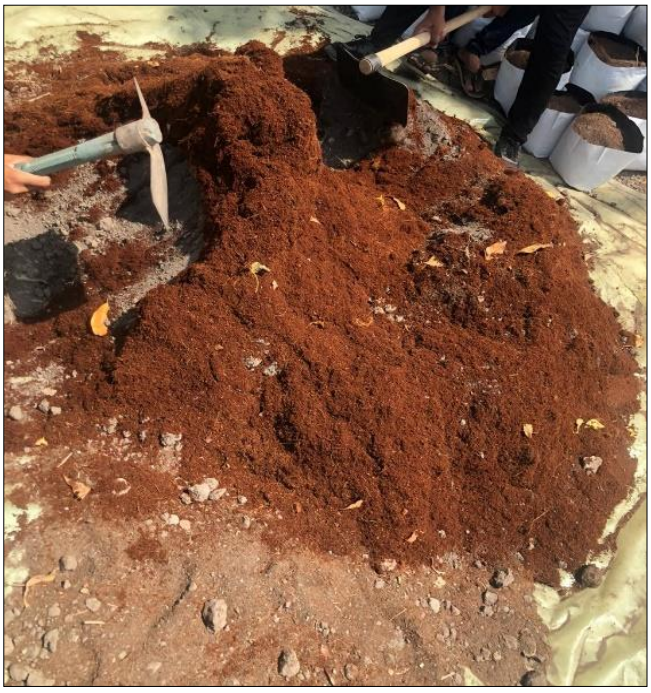
Firstly coco-peat bricks were immersed in water upto 7 to 8 hrs till it absorb water and expand 4-5 times of their volume as shown in Plate 3.6. For the different soilless treatments grow bags were filled according to the composition.

Treatment T_1 consists of 100% coco-peat growing media which is filled in 80 grow bags. Treatment T_2 is soil media for which beds were prepared. Treatment T_3 consist of coco-peat + soil media in propotion of 1:1 volume, in which equal proportion of coco-peat and soil are mixed and then filled into the grow bags. Treatment T_4 consists of vermicompost + soil media in 1:1 proportion in volume, both are mixed in equal proportion and filled in the grow bags. Treatment T_5 consist of coco-peat + vermicompost + soil media in 1:1:1 proportion all three media are mixed equally and filled in grow bags as shown in Plate 3.7 to 3.9.

All the grow bags were put into the plots maintaining plant to plant and row to row distance as per the plot design.

Adding water in coco-peat

Drying of coco-peat



Mixing of coco-peat with other media

Mixing of vermicompost with soil

Sowing of cucumber

Seeds were sown at about 4 cm depth directly in the beds and growing bags. The beds were irrigated after sowing of seeds. Gap filling was done after the germination of seeds.

Cucumber seeds sown in beds were attacked by some soil born insects which damaged seed due to which germination of seeds in bed was not possible. Sowing seed after application of insecticides FORET on bed and then again seeds were sown but they also failed to germinate. So after that seeds were placed in the tray and seedlings were raised and then transplanted to the beds after a week.

Sowing of cucumber seeds

Fertilizer application

Farm Yard Manure (FYM) was spread with insecticide initially during bed preparation. Recommended fertilizer dose of cucumber is N: P: K; 19: 19: 19 1.5 kg/ha. micronutrients or microfoods 50g per acre were applied alternate days a week.

No additional dose of fertilizers were given to the cucumber plant in any of the treatments. So the maintainance cost is minimum and fruits are also of good edible quality.

Measurements of crop parameters

Various crop parameters were measured in five replications of each treatment in polycarbonate greenhouse. Each replication was contained five plants for the measurement of crop parameters. All the observations were analysed statistically and discussed in the next chapter.

Vine length

The length of individual plant was measured at harvesting stage by measuring from the base tip to the ground using measure tape. The mean value of length of five plants were worked out.

Measurement of plant height

Number of fruits per plant (nos.)

At the time of harvesting, the matured cucumber fruits were picked from selected five plants in each treatment. The mean number of fruit sets per plant were worked out.

Weight of fruit per plant (g)

At the time of harvesting, the matured cucumber fruits were picked from selected five plants in each treatment and mean weight of fruits per plant was worked out.

Measurement of weight of fruit per plant

Dimensions of fruit per treatment (mm)

The fruit dimensions such as length and diameter of individual fruit selected randomly from each treatment was measured using Vernier caliper.

Measurement of dimension of fruit

Fruit yield per treatment (t/ha)

The fruit yield of cucumber per treatment was determined by dividing the weight of fruit obtained from all replication of a particular treatment plot with area of respective plot.

Fruit yield

Results and Discussion

Measurement of crop parameters

Cucumber crop was harvested thirteen times during entire crop season in this experiment. The crop yield from each harvest and yield per unit area for each treatment combination was computed and tabulated in Table

Cucumber crop yield from each harvest

Sr. No.	Date	T_1	T_2	T_3	T_4	T_5	Total
1	27-04-2021	0	0	0	9.1	0	9.1
2	01-05-2021	0.9	0	1	11.9	1.1	14.9
3	03-05-2021	1.1	0	3	20	2.9	27
4	06-05-2021	0.8	7	2.2	20.1	4.2	34.3
5	10-05-2021	3.2	12	4.8	19.9	3.8	43.7
6	12-05-2021	3.2	11.6	5.8	25	8.1	53.7
7	15-05-2021	9	33.4	15.2	30.5	12.9	101
8	19-05-2021	9	32.7	15.3	26.5	15	98.5
9	22-05-2021	17.3	21.7	18.4	9.1	24.4	90.9
10	24-05-2021	14.9	19.2	13.2	9	16.4	72.7
11	28-05-2021	13.8	9	7	4.8	15	49.6
12	02-06-2021	13	4.9	8.2	3.2	7	36.3
13	07-06-2021	4	1.9	5	0	6.3	17.2
Total (kg)		90.2	153.4	99.1	189.1	117.1	648.9
Yield (kg/m^2)		4.45	7.57	4.49	9.33	5.78	6.4
Yield per hectare (t/ha)		44.54	75.75	48.93	93.38	57.82	64.08

The crop yield per unit area for treatment T_1, T_2, T_3, T_4 and T_5 was found to be 44.54 t/ha, 75.75 t/ha, 48.93 t/ha, 93.38 t/ha and 57.82 t/ha, respectively.

Effect of different treatments on vine length (cm)

Statistical analysis for effect of different treatments on vine length was carried out and analyzed data presented in Table and Fig. 1 with Means, CDs, S.Em. and CV %.

Effect of different treatments on plant length

Treatment	T_1	T_2	T_3	T_4	T_5
Vine Length	181.84	218.56	159.24	233.68	199.84
S.Em.±			1.1549		
C.D. at 5%			3.407		
C.V. %			1.3		

As presented in Table the significant difference in vine length was noticed due to different treatments. The highest vine length was observed 233.68 cm with T_4 (vermicompost + soil) which was significantly higher than the rest of the treatments and lower vine length was 159 cm with T_3 (coco-peat + soil).

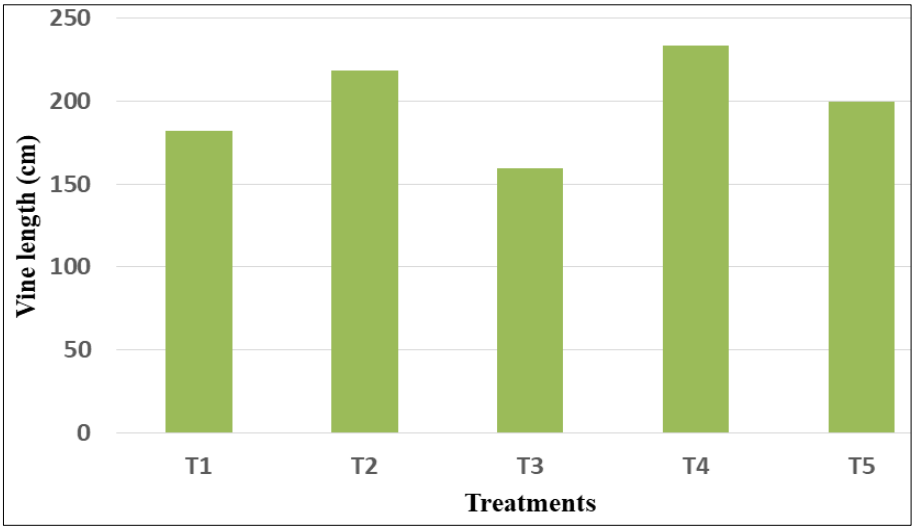


Fig 1: Effect of different treatments and environment on vine length

Effect of different treatments on number of fruits per plant

Statistical analysis for effect of different treatments and environment on number of fruits per plant was carried out and analyzed data presented in Table and Figure with Means, CDs, S.Em. and CV %.

As presented in Table the significant difference in number of fruits per plant was noticed due to different treatments. The highest number of fruits per plant was observed 11.68 with T_4 (vermicompost + soil) which was significantly higher than the rest of the treatments and lower number of fruits per plant was 5.36 with T_1 (coco-peat).

Effect of different treatments on number of fruits per plant

Treatment	T_1	T_2	T_3	T_4	T_5
No. of fruits	5.36	9.04	5.56	11.68	7.04
S.Em.±			1.4227		
C.D. at 5%			4.197		
C.V. %			8.22		

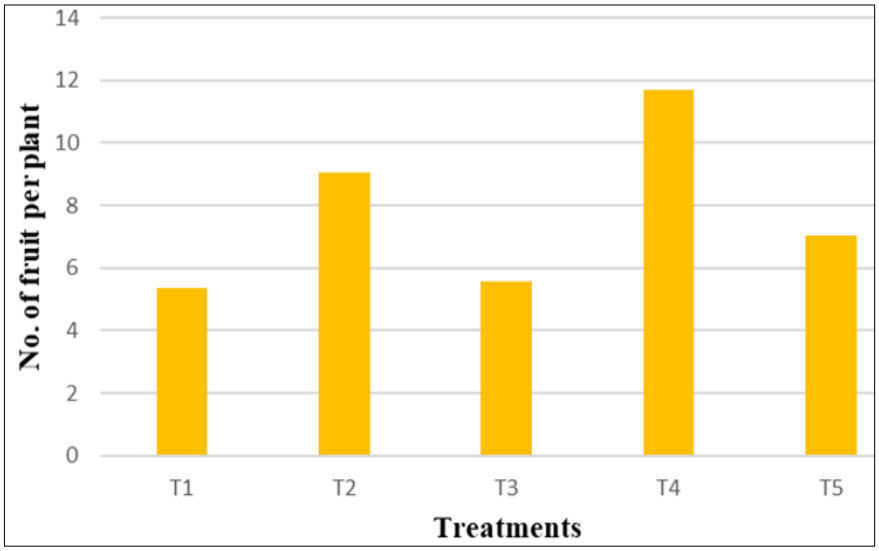


Fig 2: Effect of different treatments on number of fruits per plant

Effect of different treatments on yield per treatment (t/ha)

Statistical analysis for effect of different treatments on yield per treatment was carried out and analyzed data presented in Table and Fig. 2 with Means, CDs, S.Em. and CV %.

As presented in Table the significant difference in yield per treatment was noticed due to different treatments. The maximum yield per treatment was observed 93.38 t/ha with T_4 (Soilless media having vermicompost + soil) which was significantly higher than the rest of the treatments and minimum yield per treatment was 44.54 t/ha with T_1 (Soilless media having coco-peat). The yield was observed maximum in soilless media having vermicompost because for cucumber crop the required nutritions and soil structure was best in vermicompost media, while coco-peat media was not that much suitable for the plant growth and production as well.

Effect of different treatments on yield per treatment (t/ha)

Treatment	T_1	T_2	T_3	T_4	T_5
Yield (t/ha)	44.54	75.75	48.93	93.38	57.82
S.Em.±			0.4286		
C.D. at 5%			1.2644		
C.V. %			7.48		

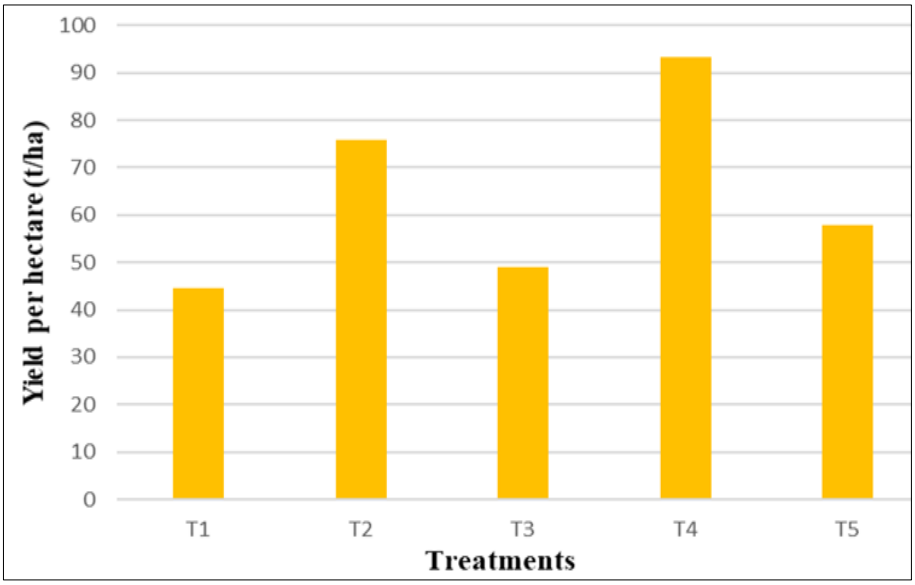


Fig 3: Effect of different treatments on yield per treatment (t/ha)

Conclusion

1. Significant difference was observed in the treatments on plant length. The highest plant length was 248 cm observed in treatment T_4 (Soilless media having vermicompost + soil) and lowest 150 cm was observed in treatment T_1 (Soilless media having Coco-peat).

2. Highest number of fruits per plant were observed in treatment T_4 (Soilless media having vermicompost + soil) (11.68 no's/plant) and lowest number of fruits per plant was observed in treatment T_1 (Soilless media having Coco-peat) (5.36 no's/plant).
3. Significantly maximum weight of fruits per plant was 2561.52 g observed in treatment T_4 (Soilless media having vermicompost + soil) and minimum weight of fruits per plant was 1220.48 g observed in treatment T_1 (Soilless media having Coco-peat).
4. Maximum diameter of fruits per plant was 48.55 mm observed in treatment T_4 (Soilless media having vermicompost + soil) and minimum diameter of fruits per plant was 42.10 mm observed in treatment combination of T_3 (Soilless media having Coco-peat + soil).
5. Highest fruit length of plant was 174.62 mm observed in treatment combination of T_4 (Soilless media having vermicompost + soil) and lowest fruit length of plant was 152.15 mm observed in treatment T_1 (Soilless media having Coco-peat).
6. Maximum yield per treatment was 93.38 t/ha observed in treatment T_4 (Soilless media having vermicompost + soil) and minimum yield per treatment was
   44.54 t/ha observed in treatment T_1 (Soilless media having Coco-peat).

References

1. Al-Far AM, Tadros MJ, Makhadmeh IM. Evaluation of different soilless media on growth, quality, and yield of cucumber (*Cucumis sativus* L.) grown under greenhouse conditions. Australian Journal of Crop Science. 2019;13(8):1388-1401.
2. Ghehsareh AM. Effect of date palm wastes and rice hull mixed with soil on growth and yield of cucumber in greenhouse culture. International Journal of Recycling of Organic Waste in Agriculture. 2013;2(17):1-5.
3. Korawan S, Johannes FJM, Suchart S, Wolfram S, Siriya K, Joachim M. Protected cultivation of tomato to enhance plant productivity and reduce pesticide use. Conference on International Research on Food Security, Natural Resource Management and Rural Development. University of Hohenheim Tropentag Stuttgart. Germany; c2013. p. 17-19.
4. Kumar A, Tyagi S, Kumar N. Protected cultivation of vegetable crops. Dimension of Agricultural Science; c2017. p. 61-68.
5. Mazahreh N, Nejatian A, Mousa M. Effect of different growing media on cucumber production and water productivity in soilless culture under UAE conditions. Merit Research Journal of Agricultural Science and Soil Sciences. 2015;3(9):131-138.
6. Resh HM. Injectors or proportional system. Hydroponics Food Production; c2001. p. 84-85.
7. Singh VK, Rajan S, Singh A, Soni MK. Protected cultivation of Horticulture. ICAR-CISH, Lucknow, U.P; c2015.