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Response of Plant Growth Regulators and Organic Manure on Benefit Cost Ratio of Cucumber in Different Hybrids of Cucumber (Cucumis Sativus L.) Under Polyhouse Condition

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ABSTRACT
*Efficient cucumber cultivation requires a thorough understanding of the interplay between cultivation practices and crop prductivity. Cucumber (*Cucumis sativus, *L.) is widely grown in polyhouse in Sirmour District as an offseason vegetable because of its high yield and economic benefits. With the help of the present study an endeavor has been recuperate to analyze the cost and return structure of cucumber cultivation under polyhouse in Sirmour. The study has been conducted with the objective to evaluate the benefit cost ratio of cucumber cultivation in polyhouse. For conducting the present study "Response of plant growth regulators and organic manure on benefit cost ratio of cucumber in different hybrids of cucumber (Cucumis sativus L.) under polyhouse condition" in the year 2024-2025 (March-July) at Experimental Research Farm Chhapang of Dr. Khem Singh Gill Akal College of Agriculture, Eternal University, Baru Sahib, District Sirmour, Himachal Pradesh. The experiment was laid out in Randomized Block Design with three replications. The research trial consisted of sixty four treatment combinations including four different hybrids (Aviva, Adiva, Fadia, Aafreen), along with three organic manures (Vermicompost, Biochar, Farm Yard Manure) and three plant growth regulators (TIBA, Kinetin, Brassinosteroid) with control were used. The outcomes of the present study revealed that (14.75, 15.93) is the benefit cost ratio for cucumber cultivation during 2024 and 2025 recorded under treatment combination* $H_1O_2P_4$ *(Aviva+Vermicompost+Brassinosteroid) under under polyhouse condition. Despite the positive outcomes, it is imperative to conduct the test on a larger scale for a more comprehensive evaluation*
Keywords: Benefit, Cucumber, Cost, Hybrids, Ratio

INTRODUCTION
In today's competitive environment and an economically globalized world, a system or organization is deemed efficient if it can produce goods at a lower energy cost (Huang et al. 2022). Cucumber (Cucumis sativus L.) holds economic significance as a popular vegetable in the Sirmour District. Cucumber ranked fourth-most important vegetable crop, behind cabbage, tomatoes, and onions (Kalloo and Bergh 2012). One of the key elements of successful cucumber production is fertilizer (inorganic or organic) (Cooke 1982). Cucumber is not only a staple raw vegetable but also a processed product known for its hydrating and skin soothing properties (Mallick 2022, Guo et al. 2023). This vegetable is laden with beneficial nutrients, including lycopene and antioxidants (Mehra et al. 2015), Cucumber (Cucumis sativus L.) is widely cultivated as a summer vegetable, valued for its high-water content and various culinary uses, including consumption in salads, cooked dishes, and pickling (Kumar et al. 2018). Consuming cucumbers on a regular basis improves immunity and metabolism (Sharma et al. 2020). It is a rich source of vitamins, minerals and antioxidants (Patel 2019), (Hao et al. 2020). Cucumber plants have male, female, and bisexual flowers, and could be classified by their flower position andappearance on the stem as gynoecious, monoecious, andromonoecious, trimonoecious, hermaphroditic, or androecious (Pawelkowicz et al. 2019). It is a thermophilic and frost-susceptible horticultural crop usually cultivated

in fields during spring-summer period or in greenhouse in different seasons (Bacci et al. 2006).
Fertilizer plays a pivotal role in cucumber production, constituting a significant portion of production costs. It has been observed that the combination of plant growth regulators and organic fertilizers enhanced fruit production and nutrient uptake. (Brien and Barker 1996), Natsheh and Mousa (2014), Agegnehu et al. 2016). Plant regulators have a beneficial effect on cucumber development, flowering, fruiting, and fruit yield. Traditionally, chemical fertilizers have played a major role in boosting crop production; however, over-reliance on these synthetic inputs has led to various environmental concerns, such as soil degradation and nutrient imbalances (Hayat et al, 2010). The need for sustainable agricultural practices has therefore led to increased interest in organic farming and the use of organic fertilizers like farm yard manure (FYM) and vermicompost. Studies by (Akanbi et al. 2002) and (Ayuso et al. 1996) have shown that the application of organic amendments such as FYM and vermicompost improves soil fertility and microbial activity, leading to better root development, enhanced nutrient availability, and ultimately higher yields. To mitigate these challenges, protected cultivation techniques, such as polyhouse farming, offer a controlled environment that enhances cucumber production by protecting crops from extreme climatic conditions and pests (Mishra et al, 2010 and Duhan 2016). Under protected structures, cucumbers are known to yield approximately 3.5 times higher than those grown in open field conditions (Ganesan and Subashini, 1999) The polyhouse cucumber's unique crispness, burpless texture, and excellent water-holding capacity make it extremely popular in both domestic and international markets (Amin et al. 2021), Shabbir et al. 2020),(Raghav and Saini2018).
Cucumber cultivation holds significant economic potential, but the associated challenges, such as high labor costs, weed management, and frequent herbicide applications, necessitate effective strategies. Recognizing the influence of organic manure and plant growth regulators, coupled with the benefits of benefit cost ratio, this study aimed to provide insights into a holistic approach to improving cucumber production. The cultivation of long-duration hybrids, and insufficient knowledge about plant growth regulators practices contribute to these issues. Additionally, inadequate organic manure with plant growth regulator application, especially neglecting the recommended doses, further hampers cucumber yield. This study aimed to address this gap by investigating the Response of plant growth regulators and organic manure on benefit cost ratio of cucumber in different hybrids of cucumber (Cucumis sativus L.) under polyhouse condition". The study hypothesized that the combined application of plant growth regulators and recommended doses of organic manure would significantly enhance cucumber growth and yield compared to conventional farming practices. The objective of this study was to assess the combined impact of plant growth regulators and organic manure on the benefit cost ratio of cucumber to provide comprehensive insights into enhancing cucumber cultivation practices to the scientific community, filling gaps in knowledge related to cucumber cultivation practices, thereby facilitating informed decision-making in agriculture.

1. MATERIALS AND METHODS

1.1 Experimental site

The study was conducted at Research Farm Chhapang, Eternal University, Himachal Pradesh, during March 2024 and 2025. The experimental site was situated at 30°44'20" North latitude and 77°18'52" East longitude, or 921 meters above mean sea level. Experimental site is situated in a semi temperate, semi humid mid hill agro.

2.2 Selection of hybrid

Selection of hybrid is an important component in experiment. In this experiment Aviva hybrid was used and sown in the month of March during 2024 and 2025. This hybrid belongs to Indosem India Pvt. Ltd. The hybrid is popular hybrid for its exceptional qualities and delicious taste. It is also good for long distance transport.

Table 2.1 Average monthly climate records

Months	Year	Temperature (^{0}C)			RH Mean (%)
		Low	High	Mean	
March	2024	10.53	24.73	26.68	61.16
	2025	10.58	26.29	18.50	56.16
	2024	14.28	30.03	22.18	49.57

April	2025	15.62	31.86	23.77	48.20
May	2024	18.74	34.59	26.68	47.23
	2025	18.04	18.04	25.13	67.33
June	2024	21.84	35.80	28.85	52.23
	2025	20.84	31.80	26.35	73.70
July	2024	23.10	32.78	27.98	78.29
	2025	21.82	30.22	26.05	88.10

2.3 Fertilizers

At the time of sowing, basal dose of FYM, vermicompost and biochar was incorporated into the plots and mixed well together. The organic fertilizers were given 5 times at an interval of 15 days. Plant growth regulators i.e. Triiodobenzoic Acid, Kinetin and Brassinosteroids were applied by spray pump onto the apical meristem and developing leaf. The initial application was made at the first true leaf stage were applied at three day intervals. Triiodobenzoic Acid was mixed in ethenol and Kinetin, Brassinosteroids was mixed in water.

2.4 Experimental details

In the research trial three different organic manure (Control, Vermicompost (5t/ha), Biochar (2.5t/ha), FYM (25t/ha) along with three plant growth regulators (Control, Triiodobenzoic Acid (10ppm), Kinetin (10ppm) and Brassinosteroids (2.0ppm) were used. The experiment was laid out in Factorial Randomized Complete Block Design in polyhouse conditions. Plot size was 1.35m×1.20m. and spacing was 45cm×30cm. For different biochemical characters, data were recorded in each replication and observations are average value recorded.

Fig.1 Overall view of experiment

Fig.1 Overall view of experiment

Table 2.2 Details of the treatment combinations

Treatment code	Treatment Combinations	Treatment details
T_1	$H_1O_1P_1$	Aviva (Control)
T_2	$H_1O_1P_2$	Aviva+Control+Triiodobenzoic Acid
T_3	$H_1O_1P_3$	Aviva+Control+Kinetin
T_4	$H_1O_1P_4$	Aviva+Control+Brassinosteroids
T_5	$H_2O_1P_1$	Adiva (Control)
T_6	$H_2O_1P_2$	Adiva+Control+Triiodobenzoic Acid
T_7	$H_2O_1P_3$	Adiva+Control+Kinetin
T_8	$H_2O_1P_4$	Adiva+Control+Brassinosteroids
T_9	$H_3O_1P_1$	Fadia+(Control)
T_{10}	$H_3O_1P_2$	Fadia+Control+Triiodobenzoic Acid
T_{11}	$H_3O_1P_3$	Fadia+Control+Kinetin
T_{12}	$H_3O_1P_4$	Fadia+Control+Brassinosteroids

T_{13}	$H_4O_1P_1$	Afreen+(Control)
T_{14}	$H_4O_1P_2$	Afreen+Control+Triiodobenzoic Acid
T_{15}	$H_4O_1P_3$	Afreen+Control+Kinetin
T_{16}	$H_4O_1P_4$	Afreen+Control+Brassinosteroids
T_{17}	$H_1O_2P_1$	Aviva+Vermicompost+Control
T_{18}	$H_1O_2P_2$	Aviva+Vermicompost+Triiodobenzoic Acid
T_{19}	$H_1O_2P_3$	Aviva+Vermicompost+Kinetin
T_{20}	$H_1O_2P_4$	Aviva+Vermicompost+Brassinosteroids
T_{21}	$H_2O_2P_1$	Adiva+Vermicompost+Control
T_{22}	$H_2O_2P_2$	Adiva+Vermicompost+Triiodobenzoic Acid
T_{23}	$H_2O_2P_3$	Adiva+Vermicompost+Kinetin
T_{24}	$H_2O_2P_4$	Adiva+Vermicompost+Brassinosteroids
T_{25}	$H_3O_2P_1$	Fadia+Vermicompost+Control
T_{26}	$H_3O_2P_2$	Fadia+Vermicompost+Triiodobenzoic Acid
T_{27}	$H_3O_2P_3$	Fadia+Vermicompost+Kinetin
T_{28}	$H_3O_2P_4$	Fadia+Vermicompost+Brassinosteroids
T_{29}	$H_4O_2P_1$	Afreen+Vermicompost+Control
T_{30}	$H_4O_2P_2$	Afreen+Vermicompost+Triiodobenzoic Acid
T_{31}	$H_4O_2P_3$	Afreen+Vermicompost+Kinetin
T_{32}	$H_4O_2P_4$	Afreen+Vermicompost+Brassinosteroids
T_{33}	$H_1O_3P_1$	Aviva+Biochar+Control
T_{34}	$H_1O_3P_2$	Aviva+Biochar+Triiodobenzoic Acid
T_{35}	$H_1O_3P_3$	Aviva+Biochar+Kinetin
T_{36}	$H_1O_3P_4$	Aviva+Biochar+Brassinosteroids
T_{37}	$H_2O_3P_1$	Adiva+Biochar+Control
T_{38}	$H_2O_3P_2$	Adiva+Biochar+Triiodobenzoic Acid
T_{39}	$H_2O_3P_3$	Adiva+Biochar+Kinetin
T_{40}	$H_2O_3P_4$	Adiva+Biochar+Brassinosteroids
T_{41}	$H_3O_3P_1$	Fadia+Biochar+Control
T_{42}	$H_3O_3P_2$	Fadia+Biochar+Triiodobenzoic Acid
T_{43}	$H_3O_3P_3$	Fadia+Biochar+Kinetin
T_{44}	$H_3O_3P_4$	Fadia+Biochar+ Brassinosteroids
T_{45}	$H_4O_3P_1$	Afreen+Biochar+Control
T_{46}	$H_4O_3P_2$	Afreen+Biochar+Triiodobenzoic Acid
T_{47}	$H_4O_3P_3$	Afreen+Biochar+Kinetin
T_{48}	$H_4O_3P_4$	Afreen+Biochar+Brassinosteroids
T_{49}	$H_1O_4P_1$	Aviva+FYM+Control
T_{50}	$H_1O_4P_2$	Aviva+FYM+Triiodobenzoic Acid
T_{51}	$H_1O_4P_3$	Aviva+FYM+Kinetin
T_{52}	$H_1O_4P_4$	Aviva+FYM+Brassinosteroids
T_{53}	$H_2O_4P_1$	Adiva+FYM+Control
T_{54}	$H_2O_4P_2$	Adiva+FYM+Triiodobenzoic Acid
T_{55}	$H_2O_4P_3$	Adiva+FYM+Kinetin

T_{56}	$H_2O_4P_4$	Adiva+FYM+Brassinosteroids
T_{57}	$H_3O_4P_1$	Fadia+FYM+Control
T_{58}	$H_3O_4P_2$	Fadia+FYM+Triiodobenzoic Acid
T_{59}	$H_3O_4P_3$	Fadia+FYM+Kinetin
T_{60}	$H_3O_4P_4$	Fadia+FYM+Brassinosteroids
T_{61}	$H_4O_4P_1$	Afreen+FYM+Control
T_{62}	$H_4O_4P_2$	Afreen+FYM+Triiodobenzoic Acid
T_{63}	$H_4O_4P_3$	Afreen+FYM+Kinetin
T_{64}	$H_4O_4P_4$	Afreen+FYM+Brassinosteroids

2.5 Characters to be recorded
2.5.1 Total Fixed Cost
2.5.2 Total Variable Cost
2.5.3 Total Benefit Cost Ratio
2.6 Statistical Analysis
Each replication's values for every observation were examined using a Factorial Randomized Block Design analysis.

Table no. 2.3 Analysis of variance

Source of variation	Degree of freedom	Sum of square	Mean sum of square	F value
Replication	r-1	RSS	RMS	
Factor A	a-1	ASS	AMS	AMS/EMS
Factor B	b-1	BSS	BMS	BMS/EMS
Factor C	c-1	CSS	CMS	CMS/EMS
AB	(a-1) (b-1)	ABSS	ABMS	ABMS/EMS
AC	(a-1) (c-1)	ACSS	ACMS	ACMS/EMS
BC	(b-1) (c-1)	BCSS	BCMS	BCMS/EMS
ABC	(a-1) (b-1) (c-1)	ABCSS	ABCMS	ABCMS/EMS
Error	(r-1) (abc-1)	ESS	EMS	
Total	rabc-1	TSS		

The analysis of variance table can be completed with these results. Once the analysis of variance is completed, the computation of critical difference and other steps are completed as with single factor experiments. The general formula for SE(d) is,

SE(d)forX=$^{\sqrt{2EMS}}$
r.D
Where,
X= the main factor or interaction
D=the product of the levels of the left our factors in X
R= number of replications

Factors example, consider a factorial RBD with factors A, B and C with levels a, b and c respectively. Then

$$SE(d)forA=\frac{\sqrt{2EMS}}{rbc}$$

$$SE(d)forB=\frac{\sqrt{2EM}}{rac}$$

$$SE(d)forC=\frac{\sqrt{2EMS}}{rab}$$

$$SE(d)forAB=\frac{\sqrt{2EMS}}{rc}$$

$$SE(d)forAC=\frac{\sqrt{2EMS}}{rb}$$

$$SE(d)forBC=\frac{\sqrt{2EMS}}{ra}$$

$$SE(d)forABC=\frac{\sqrt{2EMS}}{r}$$

3. RESULTS

Economic analysis of cucumber production

Economic analysis provides a comprehensive understanding of the financial implications of various cultivation practices, aiding decision-making for cucumber growers and agricultural stakeholders. Total production costs for each treatment were calculated by summing up all expenses incurred during the crop cultivation process. This included costs associated with seeds, organic manures, plant growth regulators, labor, irrigation, pest control. The benefit-cost ratio (BCR) was calculated for each treatment to assess its economic profitability. The BCR was obtained by dividing the net returns by the total production costs. A BCR greater than 1 indicates that the benefits outweigh the costs, making the treatment economically viable.

$$\text{Net returns (Rs/ha)} = \frac{\text{Gross returns – Cost of cultivation (Rs/ha)}}{\text{Cost of cultivation (Rs/ha)}}$$

$$\text{B:C ratio} = \frac{\text{Net return}}{\text{Cost of production}}$$

Result revealed that maximum (1518.80 and 1504.23) benefit was recorded under the treatment combination $H_1O_2P_4$ (Aviva+Vermicompost+Brassinosteroid) during 2024 and 2025. Maximum (14.75 and 9.45) benefit cost ratio was recorded under the treatment combination $H_1O_2P_4$ Aviva+Vermicompost+Brassinosteroid) during 2024 and 2025.

Total Fixed Cost

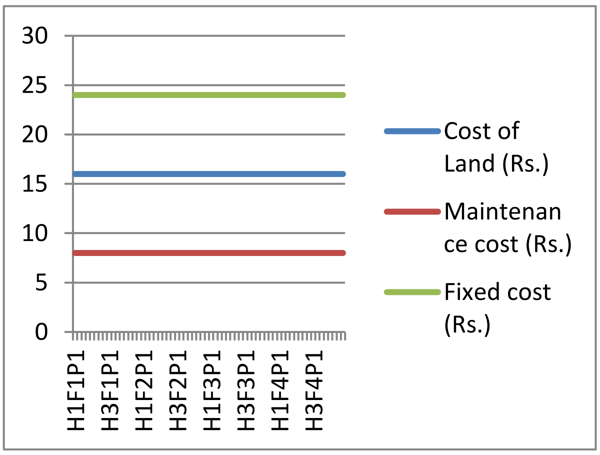
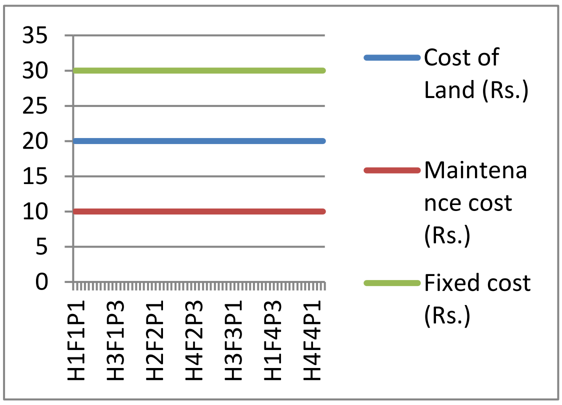


Fig.2 Total Fixed Cost 2024



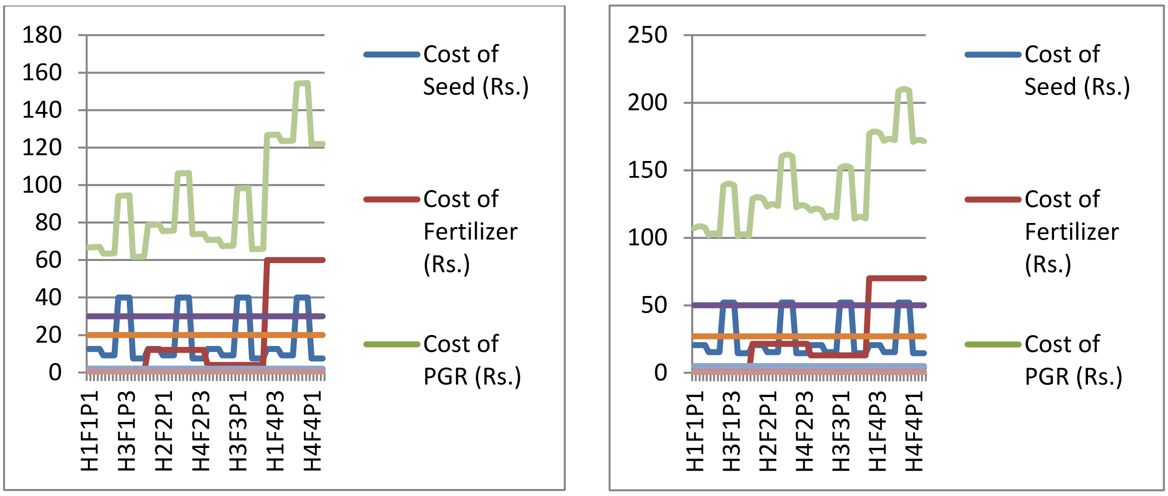


Fig. 3 Total Variable Cost 2024 Total Variable Cost 2025

Table no. 3.1 Effect of different hybrids, organic manure and plant growth regulators on benefit cost ratio on cucumber

	2024						2025					
Treatments	FC+VC=Total Cost Price	Yield /m²	Price /unit	Selling Price	Benefit	B:C	FC+VC =Total Cost Price	yield /m²	Price /unit	Selling Price	Benefit	B:C
$H_1O_1P_1$	90.70	13.37	50	668.68	577.98	6.37	137.00	8.39	50	419.50	282.50	2.06
$H_1O_1P_2$	90.80	14.23	50	711.65	620.85	6.84	138.50	9.44	50	472.00	333.50	2.41
$H_1O_1P_3$	90.80	18.93	50	946.51	855.71	9.42	138.50	12.41	50	620.75	482.25	3.48
$H_1O_1P_4$	90.97	14.83	50	741.47	650.50	7.15	137.36	10.28	50	514.09	376.73	2.74
$H_2O_1P_1$	87.40	8.76	50	437.78	350.38	4.01	131.70	5.12	50	256.12	124.42	0.94
$H_2O_1P_2$	87.50	9.22	50	461.16	373.66	4.27	133.20	5.49	50	274.52	141.32	1.06
$H_2O_1P_3$	87.50	9.08	50	453.77	366.27	4.19	133.20	5.31	50	265.51	132.31	0.99
$H_2O_1P_4$	87.67	9.23	50	461.29	373.62	4.26	132.06	5.60	50	279.95	147.89	1.12
$H_3O_1P_1$	118.20	8.09	50	404.68	286.48	2.42	168.50	5.42	50	271.00	102.50	0.61
$H_3O_1P_2$	118.30	13.04	50	652.06	533.76	4.51	170.00	6.73	50	336.65	166.65	0.98
$H_3O_1P_3$	118.30	8.93	50	446.74	328.44	2.78	170.00	6.36	50	317.78	147.78	0.87
$H_3O_1P_4$	118.47	10.17	50	508.33	389.86	3.29	168.86	7.02	50	350.83	181.97	1.08
$H_4O_1P_1$	85.70	4.63	50	231.53	145.83	1.70	131.00	4.20	50	209.94	78.94	0.60
$H_4O_1P_2$	85.80	9.11	50	455.41	369.61	4.31	132.50	7.11	50	355.74	223.24	1.68
$H_4O_1P_3$	85.80	6.62	50	331.22	245.42	2.86	132.50	4.86	50	243.20	110.70	0.84
$H_4O_1P_4$	85.97	6.82	50	341.16	255.19	2.97	131.36	5.13	50	256.29	124.93	0.95
$H_1O_2P_1$	102.73	25.25	50	1262.52	1159.79	11.29	158.50	23.71	50	1185.38	1026.88	6.48
$H_1O_2P_2$	102.83	23.32	50	1166.19	1063.36	10.34	160.00	31.52	50	1576.19	1416.19	8.85
$H_1O_2P_3$	102.83	23.87	50	1193.69	1090.86	10.61	160.00	28.12	50	1406.24	1246.24	7.79

$H_1O_2P_4$	103.00	32.44	50	1621.80	1518.80	14.75	158.86	33.26	50	1663.09	1504.23	9.47
$H_2O_2P_1$	99.43	23.17	50	1158.64	1059.21	10.65	153.20	17.12	50	856.18	702.98	4.59
$H_2O_2P_2$	99.53	18.89	50	944.62	845.09	8.49	154.70	19.74	50	986.84	832.14	5.38
$H_2O_2P_3$	99.53	15.10	50	755.21	655.68	6.59	154.70	19.04	50	951.95	797.25	5.15
$H_2O_2P_4$	99.70	19.15	50	957.55	857.85	8.60	153.56	22.32	50	1115.80	962.24	6.27
$H_3O_2P_1$	130.23	9.79	50	489.34	359.11	2.76	190.00	12.77	50	638.40	448.40	2.36
$H_3O_2P_2$	130.33	10.43	50	521.44	391.11	3.00	191.50	13.05	50	652.56	461.06	2.41
$H_3O_2P_3$	130.33	11.53	50	576.70	446.37	3.42	191.50	12.88	50	643.97	452.47	2.36
$H_3O_2P_4$	130.50	13.31	50	665.26	534.76	4.10	190.36	13.44	50	672.13	481.77	2.53
$H_4O_2P_1$	97.73	10.08	50	503.77	406.04	4.15	152.50	11.21	50	560.62	408.12	2.68
$H_4O_2P_2$	97.83	9.90	50	494.95	397.12	4.06	154.00	12.77	50	638.36	484.36	3.15
$H_4O_2P_3$	97.83	11.10	50	555.20	457.37	4.68	154.00	12.18	50	608.83	454.83	2.95
$H_4O_2P_4$	98.00	9.86	50	493.00	395.00	4.03	152.86	13.14	50	657.02	504.16	3.30
$H_1O_3P_1$	94.70	25.56	50	1278.02	1183.32	12.50	150.00	17.52	50	875.85	725.85	4.84
$H_1O_3P_2$	94.80	28.80	50	1440.13	1345.33	14.19	151.50	21.17	50	1058.66	907.16	5.99
$H_1O_3P_3$	94.80	21.69	50	1084.74	989.94	10.44	151.50	20.81	50	1040.42	888.92	5.87
$H_1O_3P_4$	94.97	20.19	50	1009.74	914.77	9.63	150.36	21.71	50	1085.27	934.91	6.22
$H_2O_3P_1$	91.40	10.31	50	515.49	424.09	4.64	144.70	13.51	50	675.52	530.82	3.67
$H_2O_3P_2$	91.50	9.47	50	473.28	381.78	4.17	146.20	14.51	50	725.37	579.17	3.96
$H_2O_3P_3$	91.50	14.40	50	719.98	628.48	6.87	146.20	13.78	50	688.84	542.64	3.71
$H_2O_3P_4$	91.67	17.59	50	879.71	788.04	8.60	145.06	15.13	50	756.33	611.27	4.21
$H_3O_3P_1$	122.20	12.26	50	612.85	490.65	4.02	181.50	8.98	50	449.10	267.60	1.47
$H_3O_3P_2$	122.30	12.85	50	642.33	520.03	4.25	183.00	10.25	50	512.67	329.67	1.80
$H_3O_3P_3$	122.30	13.77	50	688.59	566.29	4.63	183.00	9.91	50	495.47	312.47	1.71
$H_3O_3P_4$	122.47	9.05	50	452.44	329.97	2.69	181.86	10.84	50	542.16	360.30	1.98
$H_4O_3P_1$	89.70	6.96	50	348.21	258.51	2.88	144.00	5.42	50	270.89	126.89	0.88
$H_4O_3P_2$	89.80	9.14	50	457.22	367.42	4.09	145.50	5.85	50	292.68	147.18	1.01
$H_4O_3P_3$	89.80	6.45	50	322.41	232.61	2.59	145.50	5.76	50	288.18	142.68	0.98
$H_4O_3P_4$	89.97	7.52	50	376.02	286.05	3.18	144.36	6.08	50	303.82	159.46	1.10
$H_1O_4P_1$	150.70	30.94	50	1547.07	1396.37	9.27	207.00	21.09	50	1054.37	847.37	4.09
$H_1O_4P_2$	150.80	14.23	50	711.64	560.84	3.72	208.50	27.64	50	1382.02	1173.52	5.63
$H_1O_4P_3$	150.80	28.72	50	1435.93	1285.13	8.52	208.50	23.93	50	1196.73	988.23	4.74
$H_1O_4P_4$	150.97	31.89	50	1594.64	1443.67	9.56	207.36	28.23	50	1411.29	1203.93	5.81
$H_2O_4P_1$	147.40	14.38	50	719.24	571.84	3.88	201.70	13.81	50	690.40	488.70	2.42
$H_2O_4P_2$	147.50	21.82	50	1090.89	943.39	6.40	203.20	17.06	50	852.85	649.65	3.20
$H_2O_4P_3$	147.50	19.31	50	965.60	818.10	5.55	203.20	14.90	50	744.76	541.56	2.67
$H_2O_4P_4$	147.67	17.05	50	852.60	704.93	4.77	202.06	17.34	50	866.85	664.79	3.29
$H_3O_4P_1$	178.20	9.65	50	482.37	304.17	1.71	238.50	8.72	50	435.89	197.39	0.83
$H_3O_4P_2$	178.30	9.73	50	486.37	308.07	1.73	240.00	10.67	50	533.29	293.29	1.22
$H_3O_4P_3$	178.30	6.63	50	331.26	152.96	0.86	240.00	10.55	50	527.65	287.65	1.20
$H_3O_4P_4$	178.47	8.07	50	403.41	224.94	1.26	238.86	11.75	50	587.54	348.68	1.46
$H_4O_4P_1$	145.70	5.75	50	287.64	141.94	0.97	201.00	5.10	50	255.20	54.20	0.27
$H_4O_4P_2$	145.80	10.62	50	531.00	385.20	2.64	202.50	6.36	50	317.90	115.40	0.57
$H_4O_4P_3$	145.80	7.29	50	364.58	218.78	1.50	202.50	5.85	50	292.67	90.17	0.45
$H_4O_4P_4$	145.97	6.62	50	331.18	185.21	1.27	201.36	6.43	50	321.27	119.91	0.60

DISSCUSSION

The cost incurred during the production of cucumber in the study area greatly varied during both the years, it might be due to variation of the amount of inputs used. It incurred different types of cost, as it needs various kinds of inputs like seed, organic manures, plant growth regulators, irrigation, human labor, pesticides, polyhouse. Labor cost was estimated in terms of man-days and transformed into a monetary value.

The positive fixed cost, variable cost, benefit and benefit cost ratio indicate the economic viability of vermicompost and brassinosteroids for maximizing cucumber production. In contrast, the biochar, FYM and TIBA, kinetin treatments showed a lower yield. This suggests a synergistic effect of combining organic and plant growth regulators, resulting in enhanced economic returns. Both prove to be economically advantageous strategies for maximizing cucumber growth and production, as indicated by their higher benefit and BCRs compared to alternative treatments.

Similar studies reported a profit-to-cost ratio of 0.44 for date production in Khuzestan province (Hesampour et al., 2022) and a profit-to-cost ratio of 2 for potato production in Hamedan (Banaeian and Zangeneh 2011). In another study, the total cost for greenhouse cucumber production was reported as 3.246 $\$ha-1$ with a profit-to-cost ratio of 4.69 (Mohammadi and Omid 2010). Additionally, the data envelopment analysis revealed that optimizing energy consumption could reduce variable production costs by 766.21 $\$ha-1$, which accounts for about 20.18% of the total input expenditures.

CONCLUSION

The combination of organic manure (Vermicompost) and plant growth regulators (Brassinosteroids) in (Aviva) hybrid of cucumber demonstrated superior performance in terms of cucumber growth and production. This synergistic approach not only resulted in better growth but also achieved higher production levels, all while maintaining a comparatively low cost of production. The economic analysis revealed that this combined treatment yielded the highest net return and BCR among all evaluated treatments. This indicates that the integration of (Aviva+Vermicompost+Brassinosteroid) can be a judicious and economically rewarding strategy for cucumber cultivation, offering a balanced and sustainable approach to maximize both agronomic and economic outcomes (Ghimire 2023).

REFERANCES

1. Agegnehu G, Bass AM, Nelson PN and Bird MI (2016). Benefits of biochar, compost and biochar-compost for soil quality, maize yield and greenhouse gas emissions in a tropical agricultural soil. *Sci Total Environ*. 543:295-306.
2. Akanbi W, Olayiwola S, Ogunwolu M (2002). Influence of farmyard manure and vermicompost on cucumber production. *J Org Farming*. 16(2):54-59.
3. Amin MR, Nahid S and Suh SJ (2021). Impact of pollinator insects associated with cucumber fruit set. *Agric Sci Digest*. 414:615-619.
4. Ayuso M, Gutierrez M, Alvarez A (1996). Effects of organic amendments on soil fertility and cucumber growth. *Agron J*. 32(3):112-118.
5. Banaeian N, Namdari M (2011). Effect of ownership on energy use efficiency in watermelon farms-a data envelopment analysis approach. *Int J Renew Energy Resour*. 1(3):75-82.
6. Cooke GW (1982). Fertilizing for Maximum Yield. *Granada Publishing Ltd*.
7. Duhan S (2016). Protected cultivation techniques in cucumber farming. *Int J Agric Hortic*. 12(1):101-106.
8. Ganesan T, Subashini P(1999). Effect of polyhouse farming on cucumber yield in tropical regions. *J Agric Innov*. 7(4):212-220.
9. Ghimire S, Dhami D, Shrestha A, Budhathoki J, Maharjan M, et al. (2023). Effectiveness of different combinations of urea and vermicompost on yield of bitter gourd (*Momordica charantia*). *Heliyon* 9:e18663.

10. Ghimire S, Poudel Chhetri B, Shrestha J. 2023. Efficacy of different organic and inorganic nutrient sources on the growth and yield of bitter gourd (*Momordica charantia* L.). *Heliyon* 9:e22135
11. Guo Z, Qin Y, Lv J, Wang X, Dong H (2023). Luffa rootstock enhances salt tolerance and improves yield and quality of grafted cucumber plants by reducing sodium transport to the shoot. *Environ Poll*. 316:120521
12. Hao J, Li Q, Yu H, Wang H, Chai L, Miao T, Jiang W (2020). Comparative proteomic analysis of cucumber fruits under nitrogen deficiency at the fruiting stage. *Hortic Plant J*. 7:59-72.
13. Hayat R, Shah M, Rizwan M (2010). Environmental impacts of chemical fertilizers on soil health and crop productivity. *Soil Sci Rev*. 24(1):35-42.
14. Hesampour R, Taki M, Fathi R, Hassani M Halog A (2022). Energy-economic-environmental cycle evaluation comparing two polyethylene and polycarbonate plastic greenhouses in cucumber production (from production to packaging and distribution). *Sci Total Environ*. 828:154232.
15. Huang J, Hai Z, Wang R, Yu Y, Chen X, Liang W, Wang H (2022). Genome-wide analysis of HSP20 gene family and expression patterns under heat stress in cucumber (*Cucumis sativus* L.). *Front Plant Sci*. 13:1-14.
16. Kalloo G, Bergh B (1982) Genetic Improvement of Vegetable Crops. *Newnes: Pergamon*.
17. Kumar A, Yadav P, Singh R (2018). Cucumber cultivation and its nutritional benefits. *J Veg Sci*. 12(3):215-222.
18. Latimer JG (2019). Growth retardants affect landscape performance of zinnia, impatiens, and marigold. *Hort Sci*. 26(5):557–560.
19. Mallick PK (2022). Evaluating potential importance of cucumber (*Cucumis sativus* L. - Cucurbitaceae): a brief review. *Int J App Sci Biotech*. 10:12-15.
20. Mehra M, Pasricha V and Gupta RK (2015) Estimation of nutritional, phytochemical and antioxidant activity of seeds of musk melon (*Cucumis melo*) and water melon (*Citrullus lanatus*) and nutritional analysis of their respective oils. *J Pharm Phyto*. 3(6): 98-102.
21. Mishra R, Sharma S, Verma P (2010). Polyhouse farming in cucumber cultivation: A review. *Indian J Agric Eng*. 5(2):140-145.
22. Mohammadi A, Omid M (2010). Economical analysis and relation between energy inputs and yield of greenhouse cucumber production in Iran. *Appl Energy*. 87(1): 191-196.
23. Natsheh B and Mousa S (2014). Effect of organic and inorganic fertilizers application on soil and cucumber *(Cucumis sativa* L.) plant productivity. *Int J Agric For.* 4:166-170.
24. O'Brien TA and Barker AV (1996). Growth of peppermint in compost. *J Herbs Spices Med Plants.* 4:19-27.
25. Patel C, Panigrahi J (2019). Starch glucose coating-induced postharvest shelf-life extension of cucumber. *Food Chem*. 288(288): 208-214.

26. Pawełkowicz ME, Skarzyńska A, Pląder W,Przybecki Z (2019). Genetic and molecular bases of cucumber (*Cucumis sativus* L.) sex determination. Mol Breed. 39:1-27.
27. Pianco MC, Gonring AHR, Guedes RNC,Crespo ALB (2006). Critical yield components and key loss factors of tropical cucumber crops. *Crop Protection.* 25:1117-1125.
28. Raghav PK and Saini M (2018). Development of mint (*Mentha viridis* L.) herbal edible coating for shelf-life enhancement of cucumber (*Cucumis sativus* L.). *Int J Green Herb Chem*. 2: 379-391.
29. Shabbir MA, Zeshan MA, Iftikhar Y, Anwar U, Sajid A, Bakhtawar F, Mahmood R and Ghani MU (2020). Management of cucumber mosaic virus through organic and inorganic extracts in greenhouse. *Agric Sci Digest*. 40:175-177.
30. Sharma V, Sharma L and Sandhu KS (2020). Cucumber *(Cucumis sativus L.)*. Springer: Singapore.333-340.