International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 20-02-2023, Accepted: 09-03-2023, Published: 23-03-2023
Volume 8, Issue 3, 2023, Page No. 78-83

Effect of organic insect pest management strategies on brinjal production

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Abstract

A study was conducted in organic and intensive vegetable growing areas located in Manikganj and Narsingdi districts of Dhaka division. A total of 30 organic brinjal growers were interviewed from 5 randomly selected villages of Manikganj and Narsingdi. Data were collected from September 2020 to September 2021. Most frequently used pest management strategies by the organic farmers under the study areas were; T_0=Untreated control (Used resistant varieties only), T_1=Pheromone trap (Plastic pot), T_2=Sticky trap+ Neem leaf powder @ 1kg/10L of water at 7 days interval, T_3=Bait trap+ Neem leaf powder @ 1kg/10L of water at 7 days interval, T_4=Light trap+ Mahogany seed powder @ 20gm/L of water at 7 days interval and T_5= Pheromone trap + *Trichogramma evanescens* (100 points ha^{-1} at 500 wasps per point. For the untreated control of brinjal shoot and fruit borer, T_1=Pheromone trap (Plastic pot) was the most frequently used (50.67%) in the study area whereas T_5= Pheromone trap + *Trichogramma evanescens* (19.71%) was used by the least number of organic farmers besides untreated control T_0 (7.33%). Best performance was obtained from T_5 in terms of percent fruit infestation reduction over control. The highest benefit cost ratio was 1.60 recorded from the treatment T_5= Pheromone trap + *Trichogramma evanescens*, lowest benefit cost ratio was 1.42 for brinjal production from the untreated control treatment T_0. The benefit cost ratio for organic vegetable production was relatively similar and close to inorganic vegetable production practices and high yielding vegetables due to low operational cost. Although organic brinjal production was accompanied with insect pest susceptibility and less yield per hectare, high market price and increased demand among the consumers eventually minimized the gap in BCR of organic brinjal production practices with inorganic brinjal production practices.

Keywords: organic farming, organic brinjal, biocontrol agents, ecofriendly management

Introduction

One significant solanaceous crop farmed in Bangladesh is brinjal, also known as eggplant (*Solanum melongena* L.). It is a significant vegetable, and the world's third-largest producer of vegetables (BBS, 2020) [1]. Brinjal is a globally popular and economically significant vegetable among small-scale producers and consumers with low incomes (FAO, 2020) [5]. In terms of nutrition, brinjal provides significant amounts of various vitamins and minerals (Nonnecke, 1989) [13]. Despite being an annual crop, it is perennial in nature. Despite producing a significant volume of brinjal, Bangladesh only contributed a small portion to global production. Almost 1,24,526 acres of Bangladesh's total arable land are used for brinjal farming (BBS, 2020) [1]. All year round, brinjal is grown in Bangladesh. It is grown on small, family-run farms where the sale of the crop's produce provides a reliable source of year-round financial flow. It has a lot of calories, protein, riboflavin, calcium, and iron.

Depending on productivity, size, and form, as well as consumer demand, various cultivars are produced around the nation. Because to its seasonal nature of agriculture, the precise area under brinjal cultivation is not known. There were 3,78,000 metric tons of kharif and rabi brinjal produced in Bangladesh, with total cultivable areas of 22,221 hectares and 42,836 hectares, respectively (BBS, 2020) [1]. Although physical features showed a wide range of variation, very few systematic analyses of the genetic diversity in this crop have been made to date. From ancient times, brinjal has been a well-liked vegetable in our diet. Both the wealthy and the poor enjoy it. Contrary to popular assumption, it has a high nutritional content and is comparable to tomatoes (Choudhary , 2014) [2]. However, the infestation of several insects, such as the root and shoot borer, has a negative impact on its ability to produce. In the end, the control strategy that relies solely on harmful pesticides and chemicals is ineffective in the field. On the other hand, the chemicals and pesticides led to higher costs of production, environmental pollution, destruction of natural enemies, development of pesticide resistance etc.

One technology that can lessen the negative effects of agrochemicals is organic farming, which many scientists believe to be the ideal type of agriculture in terms of cost-effectiveness and pollution reduction (Christian , 2005) [3]. The production of food, fiber, and other agricultural products in an environmentally, socially, and economically sustainable manner is promoted by organic farming. The maintenance of soil fertility is seen under this system as essential to effective output. It is exempt from the use of chemo-synthetic insecticides, fertilizers, and medicines. In organic farming, appropriate cropping practices, biological untreated pest control, and natural pesticides (mostly extracted from plants or animals) are used to manage pests. Mechanical cultivation, mulching, and flaming are three cultural practices that can be used to control weed untreated control, which is the primary issue facing organic growers.

Organic farming preserves natural enemies and has a greater diversity of arthropod fauna than conventional farming (Gomiero , 2011) [6]. The holistic (whole farm) approach to pest management utilized in organic farming is heavily dependent on the ecological processes and biodiversity of the agroecosystem. As a result, organic farming systems are compatible with the majority of IPM strategies, principles, and components (Edward-Jones and Howells, 2001) [4]. This strategy aims to keep pests from causing damage to the economy without putting the environment in danger. In organic farming, successful IPM programs may include the following elements: 1) keeping an eye on crops for pests, 2) accurately identifying pests, 3) establishing financial thresholds, 4) utilizing integrated untreated pest control strategies, and 5) keeping records and evaluating the results. Under organic farming systems, the fundamental components and natural processes of ecosystems, such as soil organism activities, nutrient cycling, and species distribution and competition, are used directly and indirectly as farm management tools to prevent pest populations from reaching economically damaging levels. Soil fertility and crop nutrients are managed through tillage and cultivation practices, crop rotations, and cover crops and supplemented with manure, composts, crop waste material, and other allowed substances. The new market segment is searching for healthy and safer sources of food, and they could believe that organic foods are the solution to it (Mukul , 2013) [12]. In the present study an attempt was made to document the pattern of insect pest management in organic and intensive brinjal farming farmers' field. The objective of this work was, to gather baseline information about organic brinjal farming and current pattern of insect pest management of farmers field against insect pests, to find out the brinjal insect pest's infestation intensity in farmer field, and to estimate the cost and benefit ratio (BCR) of organic brinjal farming practices.

Materials and methods

Experimental Site

The survey was conducted in vegetable growing areas at Dhaka division in two districts. They are Manikganj and Narsingdi. And under these districts five villages were considered for data collection.

Experimental method

Technical sample organic farms were divided into thirty (30) small sample plots and each selected farmers were asked to take field walks to observe and collect 10 samples per plot (or as many as possible from early damage to late or completely damaged and/or rotten fruits/vegetables by fruit borer and aphid).

Treatments used for organic farming

Most frequently used treatments were considered to measure the effectiveness of the organic pest management strategies used by the organic farmers under the study area, the following treatments were considered:

Table 1: Treatments used by the farmers in organic brinjal production.

Treatments	Description
T_1	Pheromone trap (Plastic pot)
T_2	Sticky trap+ Neem leaf powder @ 1kg/10L of water at 7 days interval
T_3	Bait trap+ Neem leaf powder @ 1kg/10L of water at 7 days interval
T_4	Light trap+ Mahogany seed powder @ 20gm/L of water at 7 days interval
T_5	Pheromone trap + *Trichogramma evanescens* (100 points ha^{-1} at 500 wasps per point)
T_0	Untreated control (Used resistant varieties only)

Data collecting parameters

Data on vegetable insect pest infestation were collected from organic farms under the study area in each region. For this, 10 plants were selected from each organic farmers and vegetables were observed visually at three (3) harvesting stage. Organic vegetables with characteristic of damage symptoms of fruit borer and aphid were observed and recorded from each plant. Suspected fruit borer and aphid damaged vegetables were separated from the undamaged fruits and dissected to confirm the presence of brinjal shoot and fruit borer and aphids' eggs or larvae. Number of healthy and infested vegetables was recorded for each plant and percent fruit infestation was calculated using the following formula:

$$\% \text{ Fruit infestation by number} = \frac{\text{Number of infested fruits}}{\text{Total number of fruits}} \times 100$$

The number and weight of infested and total fruit or plant parts for each treated plant and untreated control plant were recorded and the percent reductions of fruit infestation by number and by weight were calculated using the following formula:

$$\text{Percent infestation reduction over control} = \frac{X1-X2}{X1} \times 100$$

Where,

X1 = The mean value of the control plant and X2 = The mean value of the treated plant.

Benefit cost ratio (BCR)

BCR of organic brinjal product was used to compare benefit per unit of cost. The BCR was the ratio of gross return to total cost. The BCR was calculated by using following formula:

$$BCR = \frac{\text{Gross Return}}{\text{Total Cost}}$$

Statistical package

In a Microsoft Excel spreadsheet, information was gathered and compiled. The data was later subjected to a variance analysis using STATISTIX-10 software. An ANOVA was created using the f variance test, and the Least Significant Difference (LSD) Test was used to compare mean values.

Results and discussion

Pest management through untreated control

In this method, mechanical and bio-insecticides are used during the life cycle of the crops. Most of the farmers from the study area use mechanical untreated control as their primary pest management strategy besides organic farmers under the study area also use some bio-insecticides.

Considering the organic pest management methods and its ability to untreated control insect pest of brinjal was measured. A total of 6 treatments were considered as most frequently used by the organic farmers under the studied areas were as follows:

Effect of organic management practices on the infestation of insect pest of Brinjal by number at first harvest

Management practices of organic brinjal farmers in untreated controlling insect pests at first harvest have been shown in Table 2. From the survey it was observed that, most of the organic farmers were depends on the cost-effective mechanical untreated control over bio-pesticides. For the untreated control of brinjal shoot and fruit borer T_1=Pheromone trap (Plastic pot) was the most frequently used (50.67%) in the study area whereas T_5= Pheromone trap + *Trichogramma evanescens* (19.71%) was used by the least number of organic farmers besides untreated control T_0 (7.33%). Although T_1 untreated control treatment was observed as most infected brinjal field (37.34%) and T_5= Pheromone trap + *Trichogramma evanescens* showed best performance against insect pest for the organic brinjal field (14.33% infestation) with the highest reduction over untreated control percentage (61.72) against brinjal shoot and fruit borer. Considering insect pest untreated control of aphid T_4=Light trap+ Mahogany seed powder @ 20gm/L of water at 7 days interval observed as the most effective for reduction of infestation over untreated control (53.51 %).

Table 2: Effect of organic management practices on the production of healthy and infested brinjal at first harvest

Management practices	Brinjal shoot and fruit borer			Aphid		
	Practicing organic brinjal farmers (%)	Fruit infestation (%)	Reduction over untreated control (%)	Practicing organic brinjal farmers (%)	Infestation (%)	Reduction over untreated control (%)
T_0	7.33 e	37.43 a	-	8.71 e	38.01 a	-
T_1	50.67 a	26.33 c	29.65	39.67 b	21.54 d	43.33
T_2	42.33 b	27.47 c	26.60	41.33 b	27.33 b	28.10
T_3	43.33 b	21.33 d	43.01	51.03 a	24.50 c	35.54
T_4	34.50 c	18.67 d	50.12	16.84 d	17.67 e	53.51
T_5	19.71 d	14.33 e	61.72	19.30 c	21.43 d	43.62
LSD (0.05)	5.67	3.87	-	5.83	3.01	-
CV%	10.31	7.65	-	8.91	5.62	-

[In column, means containing same letter(s) are not significantly different by LSD at 5% level of significance; Treatments; T_0=Untreated control (Used resistant varieties only), T_1=Pheromone trap (Plastic pot), T_2=Sticky trap+ Neem leaf powder @ 1kg/10L of water at 7 days interval, T_3=Bait trap+ Neem leaf powder @ 1kg/10L of water at 7 days interval, T_4=Light trap+ Mahogany seed powder @ 20gm/L of water at 7 days interval and T_5= Pheromone trap + *Trichogramma evanescens*]

Effect of organic management practices on the infestation of insect pest of Brinjal by number at second harvest

Management practices of organic brinjal farmers in untreated controlling insect pests at second harvest have been shown in Table 3. From the survey it was observedthat, most of the organic farmers were depends on the cost-effective mechanical untreated control over bio-pesticides.

For the untreated control of brinjal shoot and fruit borer T_1=Pheromone trap (Plastic pot) was the most frequently used (50.67%) in the study area whereas T_5= Pheromone trap + *Trichogramma evanescens* (19.71%) was used by the least number of organic farmers besides untreated control T_0 (7.33%). Although T_1 untreated control treatment was observed as most infected brinjal field (31.03%) and T_5= Pheromone trap + *Trichogramma evanescens* showed best performance against insect pest for the organic brinjal field (9.33% infestation) with the highest reduction over untreated control percentage (58.17) against brinjal shoot and fruit borer. Considering insect pest untreated control of aphid T_4=Light trap+ Mahogany seed powder @ 20gm/L of water at 7 days interval observed as the most effective for reduction of infestation over untreated control (44.65 %).

Table 3: Effect of organic management practices on the production of healthy and infested brinjal at second harvest

Management practices	Brinjal shoot and fruit borer			Aphid		
	Practicing organic brinjal farmers (%)	Fruit infestation (%)	Reduction over untreated control (%)	Practicing organic brinjal farmers (%)	Infestation (%)	Reduction over untreated control (%)
T_0	7.33 e	31.03 a	-	8.71 e	28.33 a	-
T_1	50.67 a	21.33 c	31.26	39.67 b	20.67 d	27.04
T_2	42.33 b	21.71 c	29.97	41.33 b	24.73 b	12.70
T_3	43.33 b	17.35 d	44.09	51.03 a	23.50 c	17.05
T_4	34.50 c	12.98 d	58.17	16.84 d	15.67 e	44.65
T_5	19.71 d	9.33 e	70.00	19.30 c	19.43 d	31.40
LSD (0.05)	5.67	2.93	-	5.83	3.42	-
CV%	10.31	15.04	-	8.91	13.28	-

[In column, means containing same letter(s) are not significantly different by LSD at 5% level of significance; Treatments; T_0=Untreated control (Used resistant varieties only), T_1=Pheromone trap (Plastic pot), T_2=Sticky trap+ Neem leaf powder @ 1kg/10L of water at 7 days interval, T_3=Bait trap+ Neem leaf powder @ 1kg/10L of water at 7 days interval, T_4=Light trap+ Mahogany seed powder @ 20gm/L of water at 7 days interval and T_5= Pheromone trap + *Trichogramma evanescens*]

Effect of organic management practices on the infestation of insect pest of Brinjal by number at third harvest

Management practices of organic brinjal farmers in untreated controlling insect pests at third harvest have been shown in Table 4. From the survey it was observed that, most of the organic farmers were depends on the cost-effective mechanical untreated control over bio-pesticides. For the untreated control of brinjal shoot and fruit borer T_1=Pheromone trap (Plastic pot) was the most frequently used (50.67%) in the study area whereas T_5= Pheromone trap + *Trichogramma evanescens* (19.71%) was used by the least number of organic farmers besides untreated control T_0 (7.33%). Although T_1 untreated control treatment was observed as most infected brinjal field (31.03%) and T_5= Pheromone trap + *Trichogramma evanescens* showed best performance against insect pest for the organic brinjal field (8.21% infestation) with the highest reduction over untreated control percentage (57.86) against brinjal shoot and fruit borer. Considering insect pest untreated control of aphid T_4=Light trap+ Mahogany seed powder @ 20gm/L of water at 7 days interval observed as the most effective for reduction of infestation over untreated control (50.02 %).

Table 4: Effect of organic management practices on the production of healthy and infested brinjal at third harvest

Management practices	Brinjal shoot and fruit borer			Aphid		
	Practicing organic brinjal farmers (%)	Fruit infestation (%)	Reduction over untreated control (%)	Practicing organic brinjal farmers (%)	Infestation (%)	Reduction over untreated control (%)
T_0	7.33 e	29.26 a	-	8.71 e	26.67 a	-
T_1	50.67 a	20.33 c	30.52	39.67 b	19.33 d	27.52
T_2	42.33 b	18.50 c	36.77	41.33 b	24.50 b	8.13
T_3	43.33 b	16.35 d	44.12	51.03 a	21.50 c	19.38
T_4	34.50 c	12.33 d	57.86	16.84 d	13.33 e	50.02
T_5	19.71 d	8.21 e	71.94	19.30 c	17.67 d	33.75
LSD (0.05)	5.67	2.84	-	5.83	2.93	-
CV (%)	10.31	7.41	-	8.91	13.28	-

[In column, means containing same letter(s) are not significantly different by LSD at 5% level of significance; Treatments; T_0=Untreated control (Used resistant varieties only), T_1=Pheromone trap (Plastic pot), T_2=Sticky trap+ Neem leaf powder @ 1kg/10L of water at 7 days interval, T_3=Bait trap+ Neem leaf powder @ 1kg/10L of water at 7 days interval, T_4=Light trap+ Mahogany seed powder @ 20gm/L of water at 7 days interval and T_5= Pheromone trap + *Trichogramma evanescens*]

Number of insects per brinjal plant

The organic brinjal farmers were using different combination of mechanical and biological untreated control that have been shown in Table 5. Data revealed that, under the study area Narsingdi the organic brinjal farmers practicing the untreated control treatment resulted the highest number of Brinjal shoot fruit borer (28.33) and the lowest for T_5= Pheromone trap + *Trichogramma evanescens* (8.33). Considering the study area Manikganj the organic brinjal farmers practicing the untreated control treatment resulted the highest number of Brinjal shoot fruit borer (23.50) and the lowest for T_5= Pheromone trap + *Trichogramma evanescens* (5.63) and the number of aphid was observed (3.33) relatively high compared to Narsingdi (2.59).

Table 5: Effect of brinjal growers' practices on insect pest abundance and management of insect pests

Management practices	Number of insect pest/plant			
	Narsingdi		Manikganj	
	Brinjal shoot fruit borer	Aphid	Brinjal shoot fruit borer	Aphid
T_0	28.33 a	18.33 a	23.50 a	26.50 a
T_1	23.67 b	12.85 b	22.33 a	21.41 b
T_2	18.50 c	13.33 b	19.67 b	19.67 b
T_3	13.33 d	11.33 c	12.33 c	11.20 c
T_4	11.50 e	8.78 c	9.41 d	7.80 d
T_5	8.33 e	7.33 d	5.63 e	3.33 e
LSD (0.05)	3.43	2.59	3.72	3.98
CV (%)	5.83	10.98	15.21	11.49

[In column, means containing same letter(s) are not significantly different by LSD at 5% level of significance; Treatments; T_0=Untreated control (Used resistant varieties only), T_1=Pheromone trap (Plastic pot), T_2=Sticky trap+ Neem leaf powder @ 1kg/10L of water at 7 days interval, T_3=Bait trap+ Neem leaf powder @ 1kg/10L of water at 7 days interval, T_4=Light trap+ Mahogany seed powder @ 20gm/L of water at 7 days interval and T_5= Pheromone trap + *Trichogramma evanescens*]

Cost of pest management of organic brinjal

Total cost of production

It was observed that the lowest total cost of production of organic brinjal obtained from the treatment T_0 was 55,000.00 Tk./ ha, and the highest total cost of production T_4=Light trap+ Mahogany seed powder @ 20gm/L of water at 7 days interval was 70,000.00 Tk./ ha.

Benefit cost ratio (BCR)

Considering the untreated control of insect pest of organic brinjal, the highest benefit cost ratio was 1.60 recorded from

the treatment T_5= Pheromone trap + *Trichogramma evanescens* (Figure 1.). On the other hand, the lowest benefit cost ratio was 1.42 recorded from the untreated control treatment T_0 (Table 6.). From these results it is revealed that the trend of the benefit cost ratio was observed due to application of the different organic pest management practices against brinjal. The initial cost of production was very low compared to traditional production methods but the relatively high price and high demand of organic brinjal leads farmers to a profitable BCR.

Table 6: Organic pest management for brinjal with their effects on production cost, net return and benefit cost ratio (BCR)

Management practices	Cost of pest management (Tk. Ha^{-1})	Total cost of production (Tk. Ha^{-1})	Gross return (Tk. Ha^{-1})	Net Return (Tk. Ha^{-1})	Benefit Cost Ratio (BCR)
T_0	00.00	55,000.00	78,000.00	23,000.00	1.42
T_1	8,000	65,000.00	97,480.00	32,480.00	1.50
T_2	8,000	65,000.00	97,480.00	32,480.00	1.50
T_3	8,000	65,500.00	100,800.00	35,300.00	1.54
T_4	12,500	70,000.00	103,500.00	33,500.00	1.48
T_5	9,000	65,000.00	104,000.00	39,000.00	1.60

[Treatments; T_0=Untreated control (Used resistant varieties only), T_1=Pheromone trap (Plastic pot), T_2=Sticky trap+ Neem leaf powder @ 1kg/10L of water at 7 days interval, T_3=Bait trap+ Neem leaf powder @ 1kg/10L of water at 7 days interval, T_4=Light trap+ Mahogany seed powder @ 20gm/L of water at 7 days interval and T_5= Pheromone trap + *Trichogramma evanescens*]

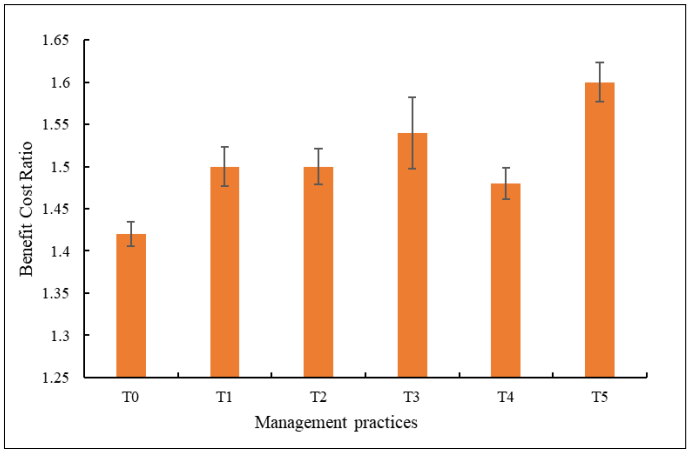
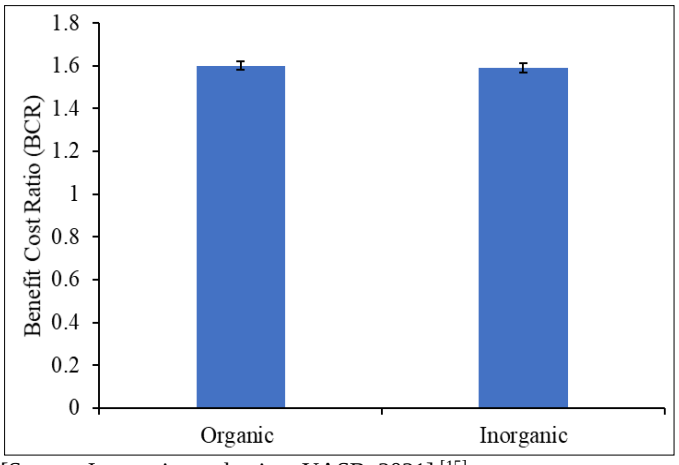


Fig 1: Benefit Cost Ratio (BCR) of organic brinjal production.

Comparison of economic analysis of inorganic and organic pest management

Results from figure 2 revealed that the trend of the comparison between inorganic and organic vegetable production for organic vegetable production benefit cost ratio was found relatively similar compared with inorganic vegetable production. In the following study comparison between the acquired secondary data for organic vegetable production benefit cost ratio was found relatively similar compared with inorganic vegetable production. The difference was minimum due to low operational cost and high market price combined with high demand so, insect pest susceptibility and less yield per hector was eventually minimized the gap in BCR for high priced organic and high yielding inorganic vegetables (Sarkar and Itohara, 2009) [14].



[Source: Inorganic production: YASB, 2021] [15]

Fig 2: Comparison of economic analysis of inorganic and organic brinjal production.

Conclusion

From the result of this study, it can be concluded that among different management practices, best performance was obtained from T_5 (Pheromone trap + *Trichogramma evanescens*) in terms of percent fruit infestation reduction over control. The highest benefit cost ratio was 1.60 recorded from the treatment T_5= Pheromone trap + *Trichogramma evanescens*, whereas the lowest benefit cost ratio was 1.42 for brinjal production from the untreated control treatment T_0.

Authors Contributions

All authors contributed to the completion of this work. Author, Md. Rakibuzzaman planned and conducted the work on the field, collected the data, statistical analysis, managed literature searches and wrote the manuscript. Authors, M. M. Rahman, M. S. Hossain and Md. Emam Hossain planned, designed and supervised the research in field as well as edited manuscript. The final manuscript was read and approved by all authors.

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