INVESTIGATION OF DRIP IRRIGATION WITH FERTIGATION FOR ENHANCING CUCUMBER YIELD IN UZO-UWANI ENUGU STATE, NIGERIA

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ABSTRACT

This study compares the effectiveness of three agricultural methods on cucumber growth and yield: chemical fertilizers, fish water through fertigation, and traditional farming with manure. Conducted over a specific period, each method was applied to separate plots of cucumber plants, with measurements taken for plant height, leaf area, fruit size, and overall yield. The results showed that the fertigation method using fish water produced the highest growth rates and yields, attributed to the rich nutrients in fish water, which enhance leaf area, foliage health, and fruit size. Traditional farming with manure also yielded positive results, though slightly lower than fertigation, indicating the value of organic practices. In contrast, the chemical fertilizer method resulted in decent growth but lagged in overall plant health and yield compared to the other two methods. This suggests that while chemical fertilizers can promote growth, they may lack the holistic benefits provided by organic alternatives. The study concludes that fish water fertigation is a highly effective and sustainable method for boosting cucumber growth and yield, while traditional manure-based farming remains a viable, if slightly less productive, organic option.

Keywords: Cucumber growth, Fertigation, Fish water, Organic farming, Yield comparison

1. INTRODUCTION

Drip irrigation and fertigation are two examples of technologies that can raise water use efficiency (WUE) and lower salinization while preserving or raising yields. In a drip irrigation system, fertilization is an agricultural water management technique that simultaneously feeds water and fertilizer to a crop. Soluble fertilizers are injected into the water and then transported to the root zone, feeding the crop. Fertigation is a new fertilizing technique used in precision agriculture that can increase the effectiveness of fertilizer and irrigation water.

In China, fertigation technology was widely used in the late 1970s, especially in the North and Northwest regions, where severe water shortages existed. The fruit output of cucumbers was 20–30% higher in drip fertigation than in furrow irrigation in systems that combine drip irrigation and fertilizer application (Hebbar et al., 2004). It is common knowledge that the two main constraints restricting the development of vegetables and crops in arid and semiarid locations are water and fertilizerIn Poland, cucumbers are among the most often consumed vegetables. The high requirements of this vegetable species for soil nutrient content and water are characteristic (Rubatzky & Yamaguchi 1997, Sady 2000). When cucumber plants are irrigated, they can produce 50% more fruit with a higher quality and greater suitability for pickling (Kaniszewski 2005). Vegetable field farming is increasingly using drip irrigation (Jeznach & Pierzgalski 1996).

When compared to alternative irrigation techniques, the drip irrigation system has several benefits, such as reduced water usage, a decline in disease incidence, increased yields, and superior produce quality (Hochmuth 1994). Drip irrigation is also a very good solution for combining fertilization with irrigation, or, in other words, fertigation. By employing fertigation, it is possible to adjust doses and times of fertilizer application to the actual requirements of plants, thus increasing yields, decreasing fertilizer consumption, and limiting unfavorable effects of environmental factors on plants (Hartz & Hochmuth, 1996).According to Hebbar et al. (2004), cucumber is a heavy feeder of nitrogen (N), phosphate (P), and potassium (K) fertilizer and reacts effectively to fertilizer treatment. It works in part with drip irrigation, which uses water and nutrients very well (Liu et al., 2011; Isah et al., 2014). According to earlier research (Liu et al., 2011; Zhang et al., 2010), the N rate of 271 kg ha produced the highest marketable yield and 265 kg ha produced the best economic yield. As the fertilizer N rate increased, the efficiency of N use and N agronomic efficiency fell as well.

Cucumber production requires phosphorus, potassium, and nitrogen, and the balanced fertilization rates advised include twice as much N as P and K. Low water production and degradation are brought on by the overuse of irrigation water. The cucumber is the most widely grown produce worldwide, although it is vulnerable to a lack of water in the soil (Yang et al. 2017; Hou et al. 2020). To gain a higher return and water productivity for cucumber production in open field circumstances, the use of suitable irrigation methods and maintaining optimal soil moisture levels are essential. Priority must be given to water efficiency to enhance cucumber productivity, both to increase yields and to reduce water consumption by reducing unproductive water use. With the drip irrigation technique, excess irrigation can be decreased by 20–50% without affecting yield (Yang et al. 2017). The drip irrigation system is currently used extensively in many nations to grow tomatoes, cucumbers, melons, peppers, and other plants during the winter, offering a number of benefits (Wang et al. 2019a, b; Liu et al. 2022). According to earlier studies, drip irrigation uses less water than the traditional furrow irrigation system. Additionally, compared to drip irrigation, crop yields were lower with furrow irrigation (Sun et al. 2019; Li et al. 2021a, b).

The highest water use efficiency over furrow irrigation is achieved by drip irrigation systems, which maintain proper soil moisture and significantly reduce evaporation losses. This results in good crop response for cucumber production (Musa et al. 2014; Chen et al. 2018; Chakma et al. 2021). When compared to Bangladesh's furrow irrigation system for strawberries, drip irrigation maintained more consistent soil moisture, plant growth, and fruit yield (Dash et al. 2020). Although drip irrigation systems use water more effectively, their rising installation and maintenance costs prevent low-income farmers in many developing nations from adopting them widely (Fathel 2020). These call for the creation of a reliable, affordable drip irrigation system that satisfies the needs of low-income farmers. Drip irrigation system subsidies from the government may be available through the National Agricultural

Technology Project, which is anticipated to increase agricultural output and farm income (World Bank, 2014).

In order to increase the fruit yield and WUE, it is crucial to develop efficient agricultural water use, which is not only necessary but also practicable. The best management of both water and fertilizer is necessary for commercial cucumber production to produce high yields and maximize profits. Prior research has concentrated on how fertilizer rate and irrigation volume affect cucumber growth, fruit yield, and quality. To enhance agricultural water and fertilizer management practices, an ideal combination of irrigation and fertilization must be chosen. This study aims to compare the use of a drip irrigation system for fertigation of cucumber using manure (animal dung) as control and synthetic fertilizer and fish water waste.

2. STUDY AREA

The study was conducted at the Agricultural and Bioresources Engineering farm of the University of Nigeria, Nsukka. The farm, where fish water waste, fertilizer, and control (manure) were applied, covers approximately 3.3 square meters. It is located at a latitude of 5° 50′N and a longitude of 7° 22′E (Ezenne et al., 2010). This region experiences two distinct seasons: the dry season from November to March and the rainy season from April to October. The climate is humid tropical, and the soil is primarily sandy loam. The majority of the local population engages in peasant farming, especially during the rainy season. A small percentage, particularly those near the river, also grow vegetables during the dry season.

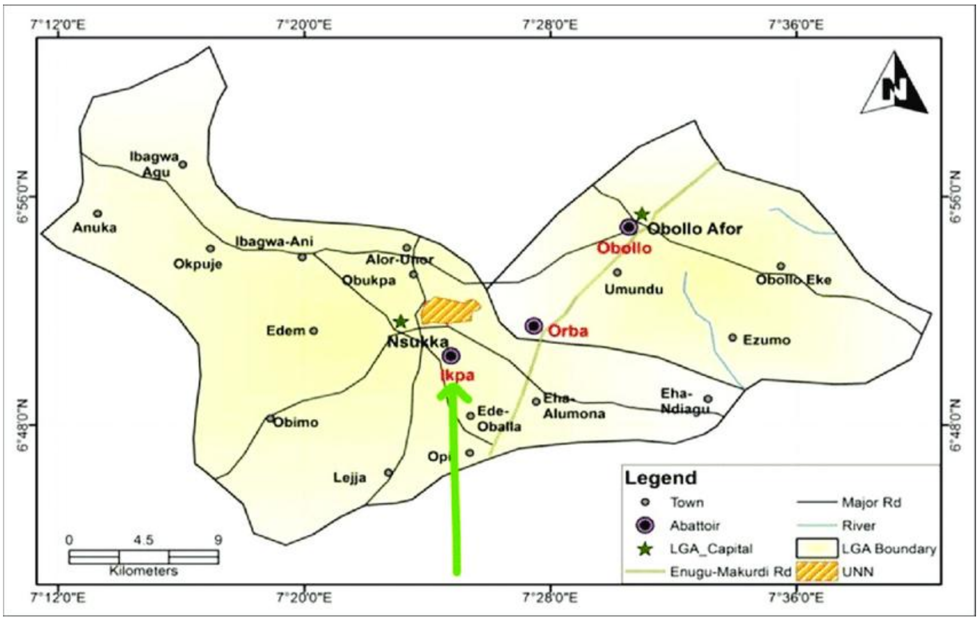

Figure 3.1 map of Nsukka showing the study area.

Materials

Hospital drip line: Used for drip irrigation, which delivers nutrients and water directly to the plant's root zone.

Wood: Used to construct stands for water cans and to stake cucumber stems.

Filter/Net: Filters solid particles that cannot pass through the drip line.

Cucumber seeds, Fertilizer, water, fish wastewater, container, rope , volumetric cylinder and tape.

Methodology

Questionnaires were used to gather information from local farmers about general cucumber farming management techniques. The responses helped to improve local farming methods.

Site Preparation

Existing vegetation was cleared using a machete. Plowing was done to break up the soil, improve aeration, and create rows. Manure was added to enhance soil fertility and structure based on the soil type. The irrigation system (drip irrigation) was set up before planting. A black PE-film hosepipe with tiny, 2-mm diameter holes was laid at the base of the plants. The soil was levelled or slightly sloped in the direction of the tube. The hose lengths ranged from 20 to 30 meters, with a water pressure of approximately 0.2 atm (2 m).

The soil needed to be level, and the water pure to prevent obstruction of the tiny droplet openings. Filtering was done at the point of water entry. The water pressure used in many drip irrigation systems was between 0.1 and 0.2 atm (1 to 2 meters of water column). For small systems, this could be achieved affordably by installing a WC-float valve at the main pipe's beginning. Fertilizer in solution was added to the drip irrigation system as needed. Drip irrigation can save 30–70% of water compared to sprinkling and other methods, especially in dry climates.

Fertigation Solution

A fertigation solution of fertilizer (NPK) and fish wastewater was used. The application ratio for fertigation using fertilizer (NPK), fish wastewater, and only water as a control can vary based on the plant's specific needs and nutrient concentration in the fish water. A general guideline for fertigation is a ratio of 1:1:10, meaning 1 part fertilizer, 1 part fish water, and 10 parts water. This ratio can be adjusted based on plant requirements and nutrient content of the fish water. Soil and water testing is essential to determine the appropriate ratio for optimal growth and to avoid over-fertilization.

Crop Cultivation

The cucumber (Cucumis sativus) was selected due to its commercial importance and widespread consumption. It is a warm-season crop that thrives in the region's climate.

Data Collection

Data were collected on various growth parameters, including plant height, leaf area, fruit size, and overall yield. Measurements were taken at regular intervals to monitor the growth and development of the cucumber plants.

3. **RESULTS AND DISCUSSION**

Growth Parameters; The growth parameters, including plant height and leaf area, showed significant differences among the treatments. The fish wastewater treatment (FW) resulted in the highest growth rates, followed by the fertilizer treatment (F), and the manure (M) showed the least growth.

Table 1: Manure Length (leaf Index)cm, Fertilizer Length (Leaf Index) cm, Fish Water L

STANDS	WK1	WK2	WK3	WK 4	**STANDS**	WK 1	WK2	WK3	WK 4	**STANDS**	WK 1	wK2	W K3	WK 4
M1	3.5	13.5	16	20	**F1**	4	13.5	18.5	19.5	**FW1**	3	15.5	19	20.5
M2	2.5	8	15.5	19	**F2**	3.5	9.5	19	21	**FW2**	3.5	11	19	20
M3	3	7.5	18	21	**F3**	5.5	11	18.5	20.5	**FW3**	4	12	18.5	19.5
M4	4	10.5	16.5	17	**F4**	5	10	17.5	19	**FW4**	5	13	17.5	19
M5	5	11.5	17.5	19.5	**F5**	3.5	14	16	17.5	**FW5**	4.5	10.5	18	21.5
M6	5	10	18	18.5	**F6**	4	10	19	21.5	**FW6**	5.5	11.5	17	18
M7	4.5	12.5	16	17.5	**F7**	3.5	11	19	19	**FW7**	4	11	19.5	21.5
M8	2.5	8	18	19.5	**F8**	4	14	17	18	**FW8**	4	12	16	17
M9	2.5	11	17	17	**F9**	4	10	16.5	17.5	**FW9**	3	14	18	20.5
M10	3.5	10	16	18	**F10**	3.5	9	15.5	16	**FW10**	2	10	16.5	19
Average	3.6	10.25	16.85	18.7	**Average**	4.05	11.2	17.65	18.95	**Average**	3.85	12.05	17.9	19.65

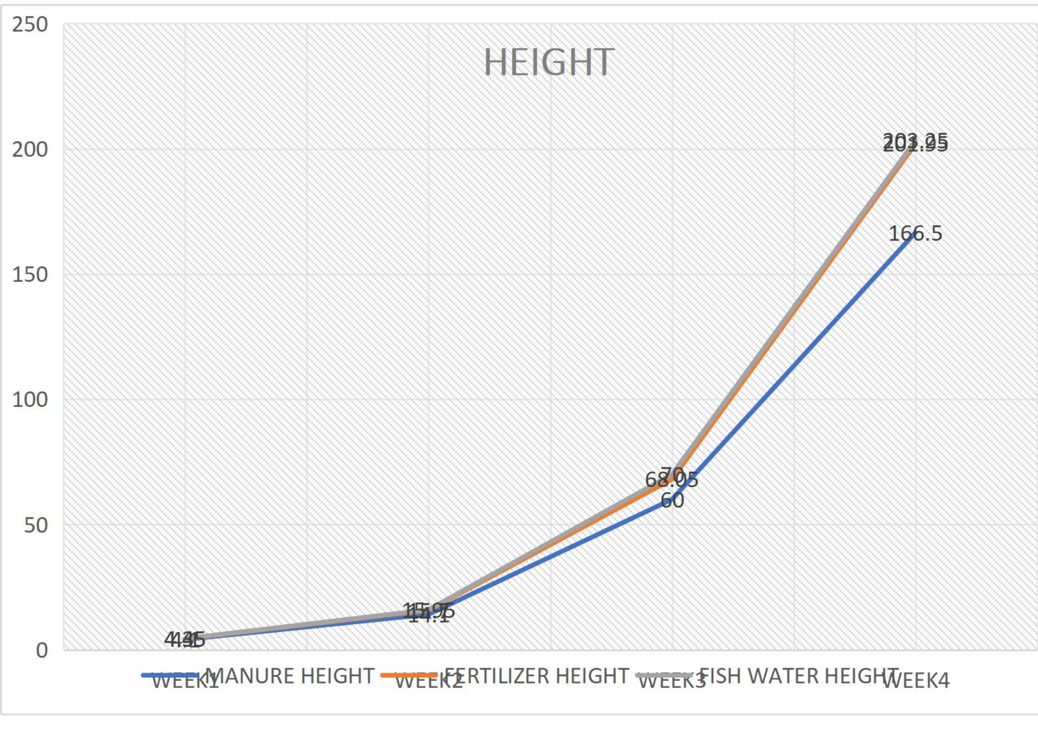

Fig. 1

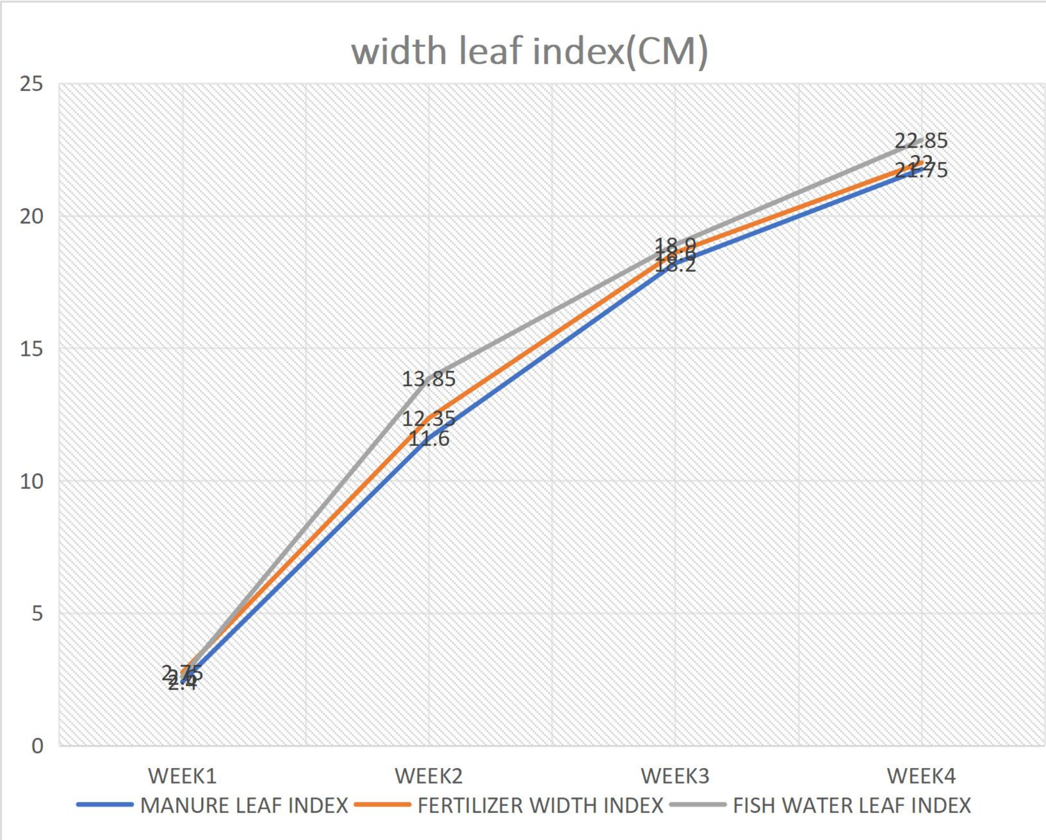

Fig.2

This results confirms the effectiveness of fish water fertigation in promoting superior cucumber growth, with fertilizer and manure following behind. The results support the study's findings on the benefits of using fish water for sustainable and enhanced agricultural productivity.

YIELD

Table 2. First harvest 29th Feb.

MANURE **FERTILIZER** **FISH WATER**

STANDS	N0.OF FRUITS	WGT.(G)	STANDS	N0.OF FRUITS	WGT.(G)	STANDS	N0.OF FRUITS	WGT.(G)
M1	1	618	F1	2	396,448	FW1	1	517
M2	1	347	F2	0	0	FW2	3	285, 398,350
M3	2	350,400	F3	2	217,450	FW3	1	500
M4	1	609	F4	2	250,396	FW4	1	347
M5	1	346	F5	0		FW5	1	449
M6	1	549	F6	1	592	FW6	1	510
M7	1	417	F7	1	528	FW7	0	0

M8	1	_	F8	1	450	FW8	1	598
M9	0	338	F9	0		FW9	0	0
M10	1	618	F10	1	390	FW10	0	0

Table 3. Second harvest 3rd March

MANURE **FERTILIZER** **FISH WATER**

STANDS	N0.OF FRUITS	WGT.(G)	STANDS	N0.OF FRUITS	WGT.(G)	STANDS	N0.OF FRUITS	WGT.(G)
M1	2	400,396	F1	1	401	FW1	1	560
M2	1	401	F2	1	449	FW2	1	476
M3	1	358	F3	1	396	FW3	1	306
M4	4	206, 200, 300, 260	F4	2	501,496	FW4	1	406
M5	1	449	F5	1	596	FW5	1	500
M6	1	418	F6	1	300	FW6	1	480
M7	1	380	F7	1	206	FW7	1	369
M8	1	410	F8	1	332	FW8	1	416
M9	1	300	F9	2	199,345	FW9	1	291
M10	1	339	F10	1	560	FW10	1	300

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Third havest 7th March

MANURE **FERTILIZER** **FISH WATER**

STANDS	N0.OF FRUITS	WGT.(G)	STANDS	N0.OF FRUITS	WGT.(G)	STANDS	N0.OF FRUITS	WGT.(G)
M1	2	200,220	F1	2	332,300	FW1	1	349
M2	1	245	F2	1	401	FW2	1	376
M3	0		F3	1	395	FW3	1	295
M4	1	300	F4	1	301	FW4	1	408
M5	1	256	F5	1	202	FW5	1	506
M6	1	201	F6	1	329	FW6	2	300,312
M7	1	345	F7	1	202	FW7	3	207,300 ,370
M8	2	296,196	F8	1	350	FW8	1	409
M9	1	290	F9	1	300	FW9	2	349, 246
M10	2	410,196	F10	0	0	FW10	1	312

From table 2 and 3 the yield data indicated that the fish wastewater treatment (FW) produced the highest fruit yield, followed by the fertilizer treatment (F), and the manure (M) yielded the lowest. The higher yield in the fish wastewater treatment can be attributed to the rich nutrients in fish water, which enhance leaf area, foliage health, and fruit size.

Therefore, while Fish Water appears to be the most effective treatment overall for both yield and fruit weight, Manure also demonstrates strong potential, particularly in terms of total fruit yield.

4. CONCLUSION

Cucumber (Cucumis sativus) is a crop that yields well within two months. This study focuses on comparing the performance of three treatment methods: fertilizer, fish wastewater using fertigation, and traditional farming with manure. The data collected included the height of the cucumber plants, leaf index, fruit weight, number of fruits, and water usage. The results show that fish wastewater performed better in terms of leaf index, fruit weight, and overall yield compared to both fertilizer and the traditional farming method using manure. The traditional farming method involved adding pig manure to the soil and watering it twice a day. This method resulted in higher water consumption due to the planting season.

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