IMPACT OF VARYING SEWAGE EFFLUENT CONCENTRATIONS ON GROWTH AND GERMINATION OF CAPSICUM SEEDS: A COMPARATIVE STUDY OF ATARODO AND SHOMBO SPECIES

**ABSTRACT**

Over the years, direct irrigation with untreated urban sewage has been found to negatively impact plants growth and yield components. The purpose of this research was to compare the effects of various concentrations of sewage effluent (0 ml, 25 ml, 50 ml, 75 ml, and 100 ml) on the growth and germination of seeds from two different species of capsicum, widely known as Atarodo and Shombo, respectively. The 2x5 factorial experiment was set up using a completely randomized design (CRD). Plant height, the number of leaves on each plant, the area of the leaves until the 12th week, the germination % at 10 days, and the days till seedling emergence were all recorded every two weeks. The acquired data were put through an analysis of variance. The days to seedling emergence for the two species differed significantly (P<0.001), according to the data. Plant height differences were found to be highly significant (P<0.01) at weeks two, four, six, and twelve. By the tenth week, there were noticeable variations in plant height (P<0.05). The two species' leaf areas differed significantly (P<0.001) from one another. At weeks 4, 8, and 12, there were highly significant differences (P<0.01) in the number of leaves per plant. The proportion of seeds that germinated was not significantly affected by the combined rate of sewage effluent. Nonetheless, 40 % of the treatment combinations had germination success rates between 50 % and 70 %. The findings show that the various sewage effluent levels significantly and favourably impacted the emergence and growth of the tested kinds of capsicum seedlings. Overall, the effects of sewage effluent on pepper appear to depend on the treatment and application method. Moderate, controlled use of sewage-derived (HS) can promote early growth, but direct irrigation with untreated sewage can be detrimental to pepper plants.

**Keywords**: Sewage Effluent, Capsicum Seeds, Germination and Irrigation

1. INTRODUCTION

Irrigation with untreated urban sewage has long been a contentious issue in agriculture, with its negative impacts on plant growth and yield components well-documented. However, the effects of sewage effluent on different species of crops are not yet fully understood. Capsicum, a popular and versatile crop, is an important part of many agricultural systems worldwide. Despite its importance, the impact of sewage effluent on capsicum growth and germination remains unclear. In recent years, concerns about water scarcity and the need for sustainable agricultural practices have led to increased interest in the use of sewage effluent as a potential irrigation source. However, the lack of research on the effects of sewage effluent on different species of crops, including capsicum, has hindered the development of effective and sustainable irrigation strategies. Sewage effluent or municipal waste water is a type of waste water that is produced from a community of people. it is characterized by volume or rate of flow, physical condition, chemical and toxic constituent. It is a composite of mostly grey water black water human waste soap and detergent and toilet papers. Sewage effluent causes wide spread water pollution. High volume of sewage water is being produced in metropolitan cities due to ever increasing population. The water collected through sewage system in outskirts of the city is discharged to agricultural lands which has both toxic effect and fertilizer value. There is an increasing use of sewage effluent for irrigation has emerged in past years as an important way of utilizing water as it contains higher amount of nutrients which increases crop yield substantially and reduces the need for fertilizer and also providing large quantities of water. Sewage water from different sources contains considerable amount of organic matter and essential which may prove beneficial for plants growth and increased crop yield (Pathak *et al.,* 1999; Ramana *et al.,* 2004; Niroula 2003; Nath *et al.,* 2009; Nagajyothi *et al.,* 2009).

The general composition of municipal waste (sewage effluent) may be classified under these categories; Organic matter- (measured oxygen demand), Diseases- (pathogen), Nutrients –(nitrogen and phosphorus ), Toxic contaminants -(both organic and inorganic), Dissolved minerals- (metals) Cd, Ni, Pb, Cr, Water. Sewage has high value of temperatures, pH, hardness, alkalinity, chemical oxygen demand, total soluble salts. The exact composition may differ from community to community.

Sewage effluent contains plant nutrients and organic matter used for pepper production/propagation, the beneficial effects have been proven by numerous researchers, it has been shown that sewage effluent application improves the physical, chemical and biological properties of the soil (Aggelides, and Londra, 2000). Chetna *et al.,* (2004) observed that waste water in any form, particularly sewage poses a threat to the growth and development and various necessary biochemical parameters of the plant. Results revealed that the chlorophyll content inside the leaves is appropriate up to the first and the second dilution level (control 100 % D.W.,20 %) whereas its reduction starts the third dilution level (50 %) and maximum of chlorophyll (mg/g) is observed in the fifth dilution level with (100 %) waste water irrigation.

In Nigeria *Capsicum* production and use has been hampered with complex problems associated with its high cost, making cultivation difficult for poor small-scale farmers (Segnou *et al.,* 2013). It has also faced abiotic and biotic constraints such as drought, extreme temperature, flooding and decrease in soil nutrients. These affects the rate of production of *Capsicum* reducing the supply and making it impossible to meet the demands of the increasing populations over the years. Inorganic fertilizer has been used in pepper propagation for high productivity, but because of its high cost, small scale farmers unable to afford this inorganic fertilizer. Sewage effluence can be used as an alternative to inorganic fertilizers which is easily available to small scale farmers.

Pepper (*Capsicum sp*) is a spice, a fruit vegetable widely cultivated in the world (Dias *et al.,* 2013; Wahyuni *et al.,* 2013).

Sewage effluent is a suspension of water and solid waste. Sewage effluent from different sources contains considerable amount of organic matter and plant nutrients (N, P, K, S, Cu, Mn, and Zn) and has been reported to increase the crop yield reducing the need for fertilizer and ultimately decreases overall cost of production. (Ramana *et al.,* 2004). This contributes greatly in agriculture as to considerably alleviate the pressure and availability of using fresh water resources and chemical composite (fertilizers). The collected effluent contains pollutants originating from households’ business and commercial establishment and industrial pollution production facilities. The general composition municipal sewage effluents are classified into five categories; organic matter, nutrients toxic, contaminants, dissolved minerals. They are several advantage and disadvantage for using sewage water for agricultural purposes and irrigation purposes. The effect of continuous irrigation with sewage effluent increases exchangeable cation to a large extent (Ambika *et al.;* 2010 Darvish *et al.,* 2010; Atemoagbo, 2024) sewage effluent application increases soil salinity organic carbon N, K, Ca, Mg, cation and may also contain significant number of toxic metals such as arsenic chromium, cadmium, copper, nickel, zinc, cobalt, magnesium and iron (Ali *et al.,* 1996).

. Many studies have shown that sewage effluent application has alleviated the levels of heavy metals in receiving soil (Singh *et al.,* 2004; Atemoagbo *et al.,* 2024). Some of these metals after accumulating in the soil are transferred into the food chain which can cause health hazards to human beings and animals. Besides these metals induce deficiency of other nutrients e.g. copper, iron and manganese inhibit plant uptake of zinc possibly because of competition for the same carrier site in soil water system. The absorption of heavy metals by plant depends on a wide range of soil factors as pH, organic matter, soil metals availability and cation exchange capacity and presence of other heavy metals in soil (Sharma *et al.,* 2006). High levels of nickel and chromium show drastic effect on dry matter production and yield. Therefore, it is important to use sewage effluent properly for effective result on germination and growth of crops. Pepper (*Capsicum*) is a tropical plant that grows in hot humid areas with a high rainfall. In Nigeria, it is mainly grown in the savanna agro-ecological zone. *Capsicum* cannot tolerate frost; it grows at temperature above 12oC and a rainfall of 2000mm annually, and a high humidity of about 75-88%, providing suitable growth conditions. Excess rainfall led to poor fruiting. Pepper requires full sunlight for its growth; they are adapted to growing at altitude up to 20cm and responds well to inorganic fertilizers (Tindall, 1983). *Capsicum* requires a well-drained silt or clay loam i.e. soil with a good water holding capacity, the soil should have at least a pH of 5.5 to 6.0 and a soil that has high humus content i.e. with optimum soil moisture. *Capsicum* is propagated mainly using seeds or by means of stem cuttings. During propagation they are some practices taken which are Nursery preparation, bed fumigation, land preparation, transplanting, fertilizer application, shading i.e. protecting from hot sun and heavy rains, watering done mainly in the morning. Excessive watering it makes it susceptible to diseases such as damping off disease and infestation. *Capsicum* produces a high return once it’s properly cultivated and pest free harvesting of *Capsicum* is usually carried out when the fruit begins to turn red but can also be harvested green. This is done once or twice in a week by hand picking.

This study aims to address this knowledge gap by investigating the effects of various concentrations of sewage effluent on the growth and germination of two popular species of capsicum, Atarodo and Shombo. By examining the impact of sewage effluent on plant height, leaf count, leaf area, germination percentage, and days to seedling emergence, this research seeks to provide valuable insights into the potential benefits and risks of using sewage effluent as an irrigation source for capsicum crops.

1. MATERIALS AND METHODS

**2.1 Materials**

The following materials were used for the purpose of this research work; Measuring tape, Perforated polythene bags, Gloves, note book and pen, Sewage effluent, Machete shovels and hoes, Measuring cylinder

**2.2 Description of *Capsicum sp* used**

A- *Capsicum annum* (shombo) Elongated, big red pepper with pointed end

B –Capsicum frutescence (Atarodo) Bell shaped pepper



**2.3 Collection of samples**

Two cultivars of pepper (*Capsicum sp*)

B

A

Fig 1-(A) *Capsicum annum* (shombo) (B) Capsicum frutescence (Atarodo)

which are Shombo (chili) (*Capsicum annum*) and Atarodo (*Capsicum frutescence*) were used to examine the effect of sewage effluent on the germination, and growth of pepper. These varieties were obtained from Calabar local market (watt market) in Cross River State, Nigeria. The sewage effluent was collected from the Calabar Municipal dump site at Lemna, Calabar, Cross River State. The polythene bags were purchased from the Ministry of Agriculture in Calabar Cross River State.

**2.4 Planting, germination and Sewage effluent treatment**

The fruits were carefully processed by dissecting, to obtain the seeds which were dried by exposing them to sunlight for 4-5 days. Pepper (*Capsicum*) has tiny seeds which required special attention to ensure their success. Thus, ten seeds of pepper were planted per bag (each experimental unit) to ensure maximum survival after thinning. The seeds of pepper were planted in polythene bags containing 2 kg of loamy soil o per bag. The treatment levels were of five levels 0ml, 25ml, 50ml, 75ml, and 100ml of effluents. After germination, the plants were treated every 2 days with the sewage effluent of different concentrations for a period of 12weeks.

**2.5 Experimental design**

The experiment was 2 x 5 factorial in a complete randomized design with 3 replicates. Where: 2 – The two species used *Capsicum frutescence* (Atarodo) and *Capsicum annum* (Shombo); 5 – The treatment levels 0ml, 25ml, 50ml, 75ml, and 100ml of effluents. Plate 1 shows the experimental set up at week 12.

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**PLATE 1: Pepper plant at week 12**

**2.6** **Data collection**

Data was collected on the following parameters fortnightly; Days to seedling emergence, Germination percentage, Plant height, Number of leaves per plant, Leave area

**2.7 Data analysis**

Data generated from these parameters at the end of the experiment were subjected to analysis of variance (ANOVA) and significant means were separated using Least Significant Difference (LSD) test.

**3.0 RESULT AND DISCUSSION**

**3.1 RESULT**

**3.1.1 Days to seedling emergence**

The result obtained showed that the effect of the concentrations of sewage effluent differed significantly (P< 0.001) in the two varieties of *Capsicum* studied, with *Capsicum annum* and *Capsicum frutescence* having a mean value of 7.39 and 8.08 days respectively. There were no significant differences between the various concentrations, combination and interaction (p> 0.001) shown in Anova Table 1. Table 1 shows that B0 and B100 had the highest mean days of 8.6.

**3.1.2 Germination percentage**

Results obtained shows no significant differences in the germination rate considering the different levels of effluents (P>0.001) shown in Anova table 3. However, the highest mean of seed germination ($\overbar{x}$=70) at the fast germination period of 10 days, occurred in *Capsicum frutescence* at 25ml combination rate when compared to other treatment (Table 1).

**Table 1: Analysis of variance for days to seedling emergence**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sov | Df | Ss | Ms | f.cal | 5% | f- tab1% | 0.1% |
| TotalCombination Factor IFactor IIInteraction Error  | 29914420 | 15.56897.33633.442.4081.48838.2326 | 0.530.8153.440.6020.3720.41163 | 1.979NS8.357\*\*\*1.4624NS0.903NS | -2.454.352.872.87- | -3.568.104.434.43- | -5.4414.827.107.10- |

\*\*- Significant (p<0.001)

Factor I = Capsicum species

Factor II = Sewage effluent levels

Table 2: Analysis of variance for germination percentage (%) at 10 days

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sov | Df | Ss | Ms | f.cal | 5% | f.tab1% | 0.1% |
| TotalCombination Factor IFactor IIInteraction Error  | 27914418 | 93253791.6667259.3589488.33333043.97455533.3333 | -421.2963259.3589122.0833760.9936307.4074 | -1.3705NS0.8437NS0.3905NS2.476 NS- | 2.464.412.932.93- | 3.608.294.584.58- | -5.5915.47.467.46- |

NS- Not significant (P>0.001)

Factor I = Capsicum species

Factor II = Sewage effluent levels

Table 3: Analysis of variance for leaf area (cm2)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sov | Df | Ss | Ms | f.cal | 5% | f-tab1% | 0.1% |
| TotalCombination Factor IFactor IIInteraction Error  | 27914418 | 656591.4943471649.30169029.3856144946.82157673.0944184942.1943 | -52405.47169029.385636236.70539418.273610274.567 | -5.10\*\*16.45\*\*\*3.53\*3.84\*- | 2.464.412.932.93- | 3.608.294.584.58- | -5.5915.47.467.46- |

\*significant (p<0.05)

\*\*significant (p<0.01)

\*\*\*significant (p<0.001)

**3.1.3 Plant height**

The result showed that significant differences were observed in varieties (factor 1) across the weeks except at 8th and 10th weeks (P>0.05), whereas the treatment combination had a highly significant difference from the 4-6weeks (P<0.001), marginally significant at 12weeks (P<0.05) and not significant at 2, 8 and 10 weeks respectively (table 3). However, interaction between varieties and treatment was not significant across the weeks (Table 3). *Capsicum frutescence* pepper has the highest growth I plant height with the mean ($\overbar{x}$= 20.89) at week 12 while *Capsicum annum* had the least growth with the mean$(\overbar{x}=14.45)$ at the 12 week (Table 1).

**3.1.4 Number of leaves per plant**

From the result obtained they was no significant difference observed in varieties (factor 1) whereas significant difference was observed at 4th and 8th weeks at (P< 0.05). The interaction between varieties (factor1) and treatment (factor 2) were not significant (P>0.05) from 2-10 weeks, but was significant at the 12th week (Table 4). The highest number of leaves were recorded with mean value of $\left(\overbar{x}=18.67\right) $for *Capsicum frutescence* at a 50ml concentration while the lowest mean $(\overbar{x}= 13.47)$ for *Capsicum annum* (Table 1).

**3.1.5 Leaf area**

The mean leaf area given in Table 1 which depicts that *Capsicum frutescence* had the highest leaf area with mean $(\overbar{x}=221.63)$ and *Capsicum annum* with the least leaf area of $(\overbar{x}=65.87)$. Analysis of variance give in Table 4 showed a very high significant differences (P<0.001) observed in varieties (factor 1) treatment factor (factor 2) and the interaction were marginally significant at (P<0.05).

**3.2 DISCUSSION**

**3.2.1 Days to seedling emergence**

The great disparity observed in the days to seedling emergence of the two-specie studied might be attributed to the nature of seeds and mineral nutrients content. Result obtained from this study agrees with Zeid and Abou (2007) that says addition of mineral nutrients contents are also important for seedling development; therefore, sewage effluent is important and useful for seedling development due to its organic and mineral content.

**3.2.2`Germination percentage**

The result showed that 40 % of the treatment combination considered recorded 50 to 70% of germination success, 50 % recorded 40-46 % germination rate while only 10% recorded below the success rate. This success was recorded because sewage effluents contain plant nutrients and organic matter used for pepper production/propagation which improves the properties of the soil (Aggelides and Londra, 2000; Atemoagbo *et al.,* 2024).

**3.2.3 Plant height**

Average plant heights showed a steady but gradual increase of plant height in all treatment combination. It was evident also that *Capsicum frutescence* at 25ml and 75ml level were significantly different at the 12th week with the mean of ($\overbar{x}$=23.83), as the plants height were highest from the observation standpoint when compared with others (Table 1). Other treatment combination levels also had means and standard error that are greater than the control, which is an indication that there is a clear relationship between plant height with respect to sewage effluent. This experiment correlates with Aggelides and Londra (2000). Which reported that sewage effluent contains plant nutrients and organic matter used for pepper production/ propagation; it has been shown that sewage effluent application improves the physical, chemical and biological properties of the soil.

**3.2.4 Number of leaves per plant**

The result obtained for leaf number plant revealed that great differences existed in concentration of the effluent used (Table 1). There was a gradual increase in the number of leaves per treatment across the weeks. *Capsicum annum* at 25ml had the highest number of leaves across the weeks with ($\overbar{x}$=23) at 12th week. *Capsicum frutescence* control had the lowest number of leaves ($\overbar{x}$=6), this clear indication that the different levels of sewage effluent had significant effect on the number of leaf. This is because sewage effluent contains plant nutrients and organic matter used for pepper production/propagation Aggelides and Londra (2000), and also has significant improvement in the growth parameter and performance of the plant.

**3.2.5 Leaf area**

Significant variation obtained in leaf area in the Capsicum species studied showed positive effect of sewage effluent on the growth performance of leaf area. Result showed a gradual increase in the leaf area of both species in relation to the treatment combination. *Capsicum frutescence* differ significantly at 100ml when compared to *Capsicum annum*.

**4.0 CONCLUSION AND RECOMMENDATIONS**

**4.1 CONCLUSION**

Two species of pepper, Capsicum annum (Shombo) and Capsicum frutescence (Atarodo), were studied to observe the effect of sewage effluent on germination and growth characteristics at different concentrations (0ml, 25ml, 50ml, 75ml, and 100ml). Samples of each pepper species were obtained from the market and planted in bags for a 12-week period (May-July). A Completely Randomized Design with three replicates was used for the study. Data was collected on the following parameters: germination percentage, days to seedling emergence, plant height, number of leaves, and leaf area. The data was subjected to analysis using Analysis of Variance (ANOVA). The results of the comparative study showed high morphometric variability among the two species, with highly significant differences observed for all growth characteristics. The increase in growth attributes due to sewage effluent treatment differed between crop species. This experiment revealed significant differences between the two lines of Capsicum annum (Shombo) and Capsicum frutescence (Atarodo) in their responses to sewage effluent.

This study demonstrates that the effects of sewage effluent on capsicum growth and germination are complex and dependent on the concentration and application method. While direct irrigation with untreated urban sewage has been shown to have negative impacts, our findings suggest that moderate, controlled use of sewage-derived effluent can promote early growth and increase seedling emergence. The significant differences in plant height, leaf count, and leaf area between the two species highlight the importance of considering the specific needs and responses of different crops when using sewage effluent as an irrigation source.

The results of this study have important implications for sustainable agriculture and water management practices. By optimizing the use of sewage effluent in irrigation, farmers and agricultural managers can reduce their environmental footprint while improving crop yields and plant growth. However, it is crucial to note that direct irrigation with untreated sewage can be detrimental to pepper plants, and proper treatment and application methods are essential to avoid negative impacts.

**4.2 RECOMMENDATION**

The study investigated the effects of various concentrations of sewage effluent on the growth and germination of seeds from two species of capsicum, Atarodo and Shombo. The results show that the different sewage effluent levels significantly impacted the emergence and growth of the tested capsicum seedlings. While the germination percentage was not significantly affected by the combined rate of sewage effluent, the study found that moderate, controlled use of sewage-derived effluent can promote early growth. However, direct irrigation with untreated sewage can be detrimental to pepper plants. These findings highlight the importance of considering the treatment and application method when using sewage effluent for irrigation purposes.

The long-term advantage in sewage disposal. It is therefore recommended that, for effective use of sewage effluent, heavy metal toxicity and accumulation risk in plants should be put into consideration. Farmers and gardeners consider using sewage effluent in a controlled manner, particularly during the early stages of plant growth. This can be achieved by diluting the sewage effluent with water to a moderate concentration, such as 25-50 ml per plant. Additionally, farmers should ensure that the sewage effluent is properly treated and monitored to prevent any potential negative impacts on plant growth and yield. Furthermore, the study suggests that the effects of sewage effluent on pepper plants may vary depending on the specific treatment and application method used.

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