**Impact of Foliar Plus on Physiological Growth Attributes of Cucumber (*Cucumis sativus*) in Owerri, Nigeria**

**ABSTRACT**

Soil applied fertilizers are associated with problems such as leaching, environmental degradation, pathogens, slow nutrient release, etc., which lead to general low performance of crops. Presently, in Owerri, South Eastern Nigeria, the use of some foliar fertilizers like Foliar Plus is fast gaining acceptance as fertilizers in growing crop vegetables such as cucumber, pepper, etc. However, huge knowledge deficit still exists in terms of the actual impact of these organic liquid fertilizers on the physiological growth and yield output of such useful crops. It has become necessary to investigate with Foliar Plus to ascertain its actual impact on certain vegetables. This stirred up the need to embark on this present work. As another quick and environmentally safe means of nutrient supply to crops, the study sought to evaluate the effect of Foliar Plus on the Physiological growth of Cucumber (*Cucumis sativus)* in Owerri. Experimental site (76m2) was prepared where cucumber seeds were planted. Randomized Complete Block Design (RCBD) was used with 3 replications. Foliar Plus (FP) was sprayed on the cucumber plant at 1-week interval with different doses (0ml [control], 120ml, 140ml and 160ml) each in 15L of water and coded as 0mlFP/15Lwater, 120mlFP/15Lwater, 140mlFP/15Lwater and 160mlFP/15Lwater respectively. Evaluations of physiological growth were done at different growth stages of development, and at harvest also. With GenStat Discovery (Edition 4), data collected were subjected to Analysis of Variance (ANOVA) and the treatment means were separated using Duncan's New Multiple Range Test at 5% level of probability.

Result indicated that Foliar Plus impacted significantly (p≤0.05) in some monitored physiological parameters as 120mlFP/15Lwater recorded 25.33 days (lowest) in days to 50% flowering, leaf area (496.62 cm2), crop growth rate (2.38g/m2/day) and specific leaf weight (0.018 g/cm2), whereas 140mlFP/15Lwater obtained the highest values, 0.020 g/cm2 and 11.27g in specific leaf weight and leaf dry weight (6WAP) respectively. Specifically, Foliar Plus, did impart significantly on the crop growth rate (CGR) and specific leaf weight (SLW) of cucumber as 120mlFP/15Lwater and 140mlFP/15Lwater gave the highest value of CGR whereas 0mlFP/15Lwater got the lowest values. The control took the highest number of days both in terms of flowering (28.53 days) and maturity (45 days). However, canopy cover (CC), crop dry weight (CDW), relative growth rate (RGR), leaf area index (LAI), net assimilation rate (NAR), leaf area ratio (LAR), leaf weight ratio (LWR) and specific leaf area (SLA) of cucumber plant were not significantly (p≥0.05) affected by Foliar Plus. In general, 120mlFP/15Lwater performed better than other higher treatment levels (doses) in almost all the parameters monitored, whereas 160mlFP/15Lwater unexpectedly performed poorly. The study concluded that with liquid organic foliar feeding/application, vegetable crop productivity can be enhanced through correcting the crop physiological imbalances occasioned by soil nutrient deficiencies. Hence, 120ml of Foliar Plus per 15L of water has been recommended as a more suitable dose for cucumber cultivation in Owerri than other doses of the treatment used in the research.

KEY WORDS: Liquid organic foliar fertilizer, Cucumber, Foliar Plus, Physiology, Growth, foliar spray

**INTRODUCTION**

Cucumber (*Cucumis sativus* L*.*) is an important profitable vegetable crop which belongs to the family Cucurbitaceae (El-Wanis, 2012), and it is one of the three most economically important cucurbits after watermelon and melon (FAO, 2006). It is also ranked fourth among vegetable crops after tomato, cabbage and onion in Asia (Eifediyi and Remison, 2010). Cucumber is believed to be perhaps the most established vegetable developed or cultivated by man with verifiable records going back 5,000 years (Wehner and Guner, 2004). It contains a wide variety of minerals and biologically active compounds such as steroids, flavonoids, tarlins, phlobotanins and steroids, imparting health benefits beyond basic nutrition and reducing risk of many deadly human diseases (Patil *et al.,* 2012). Cucumbers are typically grown as annual climbing or creeping vines, producing elongated, cylindrical, or oval-shaped fruits with green skin and edible seeds. They are known for their high-water content, making them an excellent hydrating and low-calorie food option (Ejaz & Bahadur, 2024). In spite of these good attributes and usefulness, lack of information on some important cultural practices by peasant farmers has led to low yield in the production of cucumber fruit (Ekwu *et al.*, 2007).

Soil nutrient management has been a major component of cultural practices improvement for most crops, and since most arable lands of Southeastern Nigeria are under frequent cultivation, supplemental fertilizer application is necessary. Actually, chemical fertilizers are applied to poor soils to improve their nutrient capacity and increase production, but due to frequent and inappropriate application systems, soil degradation occurs in cultivated areas (Niu *et al*., 2021). Again, it has been reported that some organic solid fertilizers like cow dung, poultry wastes and compost are potential safe areas for pathogenic organisms (Heinoneu-Tanski *et al*, 2006), in addition to heavy metal contaminants in agricultural soil. Hence, the benefits are much less than the problems/troubles as these microbes can cause diseases to plants and animals (Moreno-Caselles *et al*., 2002). Plant diseases destroy about 15% of the world’s agricultural yield, with viruses responsible for one-third of these losses on their own. The majority of viruses lead to severe symptoms that might result in a variety of physiological abnormalities in plants, endangering agricultural production and productivity (Khalid *et al*., 2025). Plant illnesses brought on by bacteria, fungi, nematodes, and other microbes are diﬃcult to manage using chemical means. Moreover, viral illnesses are a signiﬁcant factor that should be treated seriously because of the magnitude of the economic loss, the costs of managing the sickness, and the advent of new or evolved virus infections (Khalid et al., 2025).

Thus, there is a need for alternative means of enhancing plant nutrient requirements which is readily absorbed by plants, ecologically friendly and has no harmful effect on the soil. Interestingly, foliar application is another method of organic fertilizer application employed in correcting soil nutrient deficiencies when growing plants are unable to absorb them directly from the soil (Liang and Silverbush, 2002). Foliar applied fertilizer gives a speedier reaction and is more powerful for certain supplements than soil or ground applied fertilizer (Jamal *et al.,* 2006). Again, soil applied fertilizers are prone to leaching, fixation or volatilization (Mudita *et al.*, 2014). Meanwhile, foliar feeding has been used as a means of supplying supplemental doses of minor and major nutrients, plant hormones, stimulants and other beneficial substances (Kuepper, 2003) in which Foliar Plus is one of the foliar fertilizers.

Foliar Plus is a liquid organic foliar fertilizer of premium seaweed extract reinforced with essential micronutrient and macronutrients for plants. Seaweed extract is widely used as an organic product and is a growth promoter, containing organic acid and amino acid, hormones, vitamins, minerals and others (Sangha *et al.,* 2014). It improves vegetative growth and unlike chemical fertilizer, it is also environmentally friendly and does not cause environmental damage (Kuepper, 2003). Foliar feeding of nutrients is also a way of rapid correction of nutrient deficiencies and physiological disorders of crop plants (Kerin and Berova, 2003). It is economically viable in terms of vegetable production (Jaskulski, 2007), offering an effective means of reducing soil and ground water pollution (Fageria *et al.*, 2009).

Physiological processes in plants, including germination, growth and fruiting of crops, are influenced by environmental factors, most importantly soil. The environmental factors that are the main causes of abiotic stress in plants are humidity, water, light, nutrition, and temperature. Throughout all phases of growth and development, the environment impacts plants (Raza *et al*., 2024). On this premise, Gibberelic acid and potassium foliar sprays on the productive physiological and biochemical parameters of parthenocarpic cucumber showed that the minimum number of days to fruit initiation, fruit maturation and harvest was recorded in plants (cucumber) sprayed with Gebberelic and Potassium whereas the maximum values was recorded from the control (Pal *et al.*, 2016). Also, Mahnoodi *et al.* (2020) observed that foliar application of Gebberelic and Potassium organic liquid fertilizer significantly affected rice (*Oryza sativa L)* physiological traits including leaf area index, growth rate, and total dry-weight of rice plant.

Cultivated soils with nutrient deficiency are usually managed through supplemental nutrient application for optimum performance of crops. Meanwhile, due to an alarming increase in population, more land is required for crop production while continuous use of such soil has resulted in the loss of nutrients, which has consequently resulted in poor growth and yield. Furthermore, as a result of soil chemical fertilizer application, degraded and salt affected soils are gradually appearing more often in cultivated areas of the South-Eastern region of Nigeria.

Presently, in Owerri, South Eastern Nigeria, the use of some foliar fertilizers like Foliar Plus is fast gaining acceptance as fertilizers in growing crop vegetables such as cucumber, pepper, etc. However, huge knowledge deficit still exists in terms of the actual impact of these organic liquid fertilizers on the physiological growth and yield output of such useful crops. Specifically, therefore, it has become necessary to carry out an investigation with Foliar Plus to ascertain its actual impact on certain vegetables. This stirred up the need to embark on this present work, whose broad objective is to evaluate the impact of Foliar Plus on the physiological growth of cucumber (*Cucumis sativus L.*) in Owerri.

**MATERIALS AND METHODS**

**Location**

The experiment was conducted at the Teaching and Research Farm of Imo State University, Owerri in the early cropping Season of (April) 2022. Owerri, which is located on the tropical rainforest zone of Southeastern Nigeria, lies between Latitude 50°18'15" N and 50°34'45" N, and Longitude 60°56'45" E and 70°05'00" E. Owerri has a fairly flat topography with average annual rainfall of 2500mm. Again, the climatic data show that the relative humidity and temperature are 75% and 270C respectively (NIMET, 2008). Altitude of Owerri is 91.1m above sea level.

**Land Preparation/ Experimental Design**

The land was conventionally cleared and tilled manually with a Cutlass, hoe and a spade. The experimental design was Randomized Complete Block Design (RCBD) with 3 replications. Each replicate, separated from one another by 1m, contained 4 plots (or beds) for the respective treatments, giving a total number of 12 plots. The total area of the land was 8m ×9.5m (76m2) whereas the area of each plot was 2m x 2m (4m2) and separated from one another by 1m. The seeds of cucumber were planted in each plot, and the treatment applied in a randomized fashion. The field layout was mapped out with the use of measuring tape, a line and pegs.

**Soil Analysis**

Soil samples were collected from the experimental site (from 0 - 15cm soil depth) before planting. The soil sample was air dried at room temperature, passed through a 2mm sieve and kept in a black polythene. The collected soil was analyzed for physico-chemical properties.

**Experimental Materials and Treatment**

Seeds of cucumber were collected from Imo Agricultural Development Programme (Imo ADP).

Foliar Plus (complete) was bought from the licensed distributors.

**Treatment Application**

Foliar Plus were applied on the foliage of the plant (that is on the leaves and stems) 1 week after sowing, at 1-week intervals and monitored until fruits are formed. Different treatment levels of Foliar Plus applied are as follows:

1. 0ml Foliar Plus/15 litres of water (0mlFP/15LWater) (Control)
2. 120ml Foliar Plus/15 litres of water (120mlFP/15LWater)
3. 140ml Foliar Plus/15 liters of water (140mlFP/15LWater)
4. 160ml Foliar Plus/15 litres of water (160mlFP/15LWater)

**Sowing and Staking**

Cucumber seeds were planted at a spacing of 50 cm × 50 cm. Seeds of cucumber were sown per hole at a depth of 2.0 cm. Seedlings were later thinned to one, one week after planting, and a number of 16 seedlings were left growing per plot. Four plant stands were tagged for data collection in each plot.

Staking: Stakes were provided for trailing cultivars after the first week of emergence.

**Weeding**

Weeding was done manually by hand with a weeding hoe for two times.

**Data Collection**

Plant leaf area and plant dry weight formed the bases for primary data collection on growth analysis. Growth analysis of cucumber bordered on the observations or study of growth parameters associated with the physiological life time of the plant to its death.

The primary data were obtained by meticulously uprooting the first two plants from each plot at 4 weeks (1st harvest) during vegetative growth, and the process was repeated at 6 weeks (2nd harvest) during flowering. The plants were lifted out with a ball of earth using a shovel. A circumference of 20cm was maintained around the plants with a depth of 30cm for the purpose of total root recovery. Thereafter, the roots were carefully washed to get rid of attached soil by dipping them in a container of water. The harvested plants were then destructively analyzed by separating them into three parts (i.e. leaf, stems and roots). These were then oven-dried at 72**o** C for 10hrs to a constant weight and subsequently weighed with an Accolab sensitive electronic weighing balance to determine the dry weight of each component part (leaf, root and stem).

Actually, data collection commenced 2 weeks after sowing and at 2-week intervals. Data were collected on the following physiological growth parameters:

* Days to 50% flowering: The number of days from planting to the time when 50% of the plants had at least one open flower.
* Days to 50% Maturity: Regarded as the number of days from planting to the time when 50% of the plant matured.
* Leaf Dry Weight (kg): This was obtained by drying the leaf in an oven at 750 C for 2 hours and the weight was obtained using an electronic weighing balance.
* **Leaf Area (LA):** The length (L) of the leaf was measured from the lamina tip to the point of intersection of lamina and petiole, and the width(W) was measured tip to tip between the widest lamina lobes (Blanco and Folegetti, 2005). Model used to estimate/predict leaf area of cucumber crop in an open field was:

L.A = 210.61 + 13.358W + 0.5356LW (Cho *et al.,* 2007)

* **Crop Dry Weight:**  This was obtained by uprooting two plants and drying in an oven, and then a sensitive electronic weighing balance was used to determine the weight in grams (g). This was done twice at 4 weeks and 6 weeks after planting.
* **Canopy Cover (CC):** A distance(r) was measured (with tape rule) on the ground from the base of the plant to the point where the tip of a lateral leaf could be traced vertically to that point on the ground. At this point, a circular line was drawn around the plant within which the area was estimated using the formula below:

Canopy cover = πr2

Where r= the radius of the circular area

* **Leaf Area Index (LAR):** This shows the ratio of leaf surface area to the ground area occupied by the crop. It is given by:

LAI = $\frac{LeafofArea}{Areaofgroundcovered}$

* **Leaf Area Ratio (LAR).** This measures the ratio of the leaf area to the whole plant dry weight and is a further measure of the efficiency of the leaf surface in producing dry matter (Radford, 1967). I.e.

LAR = $\frac{I1+I2}{W1+W2}$ = $\frac{TotalLeafArea}{Toatldryweightofplant}$

Where I1 +I2 represent the total leaf areas, and W1 and W2 represent whole plant

weight.

* **Relative Growth Rate (RGR):** It is a measure of dry weight increase in plant matter over a time interval in relation to the initial weight, which is the parameter used to measure crop plant growth time (Radford, 1967). This is expressed as:

RGR = $\frac{(LogeW2-Logw1 )}{(t2-t1)}$

where;

 W1 = crop dry weight at first harvest

 W2 = Crop dry weight at second harvest

 t1 = Days for the first harvest

 t2 = Days for the second harvest

 Loge = Natural logarithm

* **Net Assimilation Rate (NAR):** This is a measure of production efficiency of the leaf of the crop. Usually, it is expressed in gram per square meter per week (Radford, 1967)

**NAR =** $\frac{(W2-W1)(Loge^{l2}-Loge^{l1})}{\left(t2-t1\right)(L2-L1)}$

Where:

W = Plant dry weight

L1 = Initial leaf area

L2 = Subsequent Leaf area

W1 = Crop dry weight at first harvest

W2 = Crop dry weight at second harvest

t1 = Days for the first harvest

T2 = Days for the second harvest

Loge= Natural logarithm.

* **Leaf Weight Ratio (LWR):** This expresses the ratio of the leaf dry weight to total dry weight of the crop and is calculated from:

LWR = $\frac{(LW1/W1)+(LW2/W2)}{2}$

Where:

 LW1 = the leaf dry weight at first harvest

 LW2 = the leaf dry weight at second harvest

 W1 = Crop dry weight at first harvest

 W2 = Crop dry weight at second harvest

* **Specific Leaf Weight (SLW):** This indicates the ratio of the leaf area, which can be obtained from the formula:

SLW = $\frac{(LW1/LA1)+(LW2/LA2)}{2}$

Where:

LW = Leaf dry weight

LA = Leaf Area.

* **Specific Leaf Area (SLA):** It is an estimate or measure of the change in leaf area per unit of leaf weight between harvest (Radford, 1967)

SLA = $\frac{(LA1/LW1)+(LA2/LW2)}{2}$

Where:

LA = Leaf area

LW = Leaf dry weight

* **Crop Growth Rate:** Regarded as a measure of the rate of dry matter production per unit time. Crop dry weight per unit at one harvest (W1) will be deduced from that of the next harvest (W2) and the difference divided by the number of days between harvest (T2 - T1 in days) (Radford, 1967).

CGR = $\frac{W2-W1}{T2-T1}$

Where:

 W = dry weight of plant materials per unit area of ground.

 T = time in days, and the subscripts 1 & 2 refer to first and second harvest respectively.

 **RESULT AND DISCUSSION**

**Result**

***Effect of Foliar Plus on Days to 50% flowering (D50%F) of Cucumber***

The effect of Foliar Plus on days to 50% flowering of cucumber was presented in Table 1. Statistical analysis showed that Foliar Plus did produce a significant (p≤0.05) effect on days to 50% flowering of cucumber. The control (0mlFP/15Lwater) took the highest number of days (28.53 days) for the cucumber to flower, significantly (p≤0.05) different from 120mlFP/15Lwater which took 25.33 days. However, the value obtained from the control treatment was statistically similar to 26.67 days and 28.00 days taken by the cucumber plants treated with 140mlFP/15Lwater and 160mlFP/15Lwater respectively (Table 1).

***Effect of Foliar Plus on Days to 50% Maturity***

In Table 1 it was shown that Foliar Plus had a significant (p≤0.05) effect on days to maturity of Cucumber. From the analysis, 45.00days was recorded for 0mlFP/15LWater, which was significantly different from 120mlFP/15LWater (39.67 days) and 140mlFP/15LWater (39.67 days), but statistically (p≥0.05) similar to 160mlFP/15LWater (38.67days).

***Effect of Foliar Plus (FP) on Leaf Dry Weight of Cucumber (LDW)***

Table 1 also indicates the effect Foliar Plus had on LDW of Cucumber both at (4WAP) and harvest (6WAP). At 4WAP, 140mlFP/15Lwater produced the highest value (9.53g/plant) whereas the control (0mlFP/15Lwater) gave the lowest value with 5.53g/plant, though with no significant (p≥0.05) differences between them and those of 5.97g/plant and 9.30g/plant values produced by 120mlFP/15Lwater and 160mlFP/15Lwater respectively.

However, at 6WAP, 140mlFP/15Lwater with value a 11.27g/plant LDW, was significantly (p≤0.05) higher than the control (8.67g/plant), but statistically similar to 120mlFP/15Lwater and 160mlFP/15Lwater treatments which gave 9.57g/plant and 10.00g/plant respectively (Table 1).

**Table 1. Effect of foliar plus (FP) on days to 50% flowering, days to 50% maturity and leaf dry weight (LDW) of cucumber at 4WAP and 6WAP**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  Treatments |  Days to 50%  Flowering |  Days to 50%  Maturity | 1stLeaf Dry Weight  (LDW)  4WAP  | 2nd Leaf Dry Weight  (LDW)  6WAP  |
| 0mlFP/15Lwater |  28.53a |  45.00a |  5.53a |  8.67b |
| 120mlFP/15Lwater |  25.33b |  39.67b |  5.97a |  9.57ab |
| 140mlFP/15Lwater |  26.67ab |  39.67b |  9.53a |  11.27a |
| 160mlFP/15Lwater |  28.00ab  |  38.67ab  |  9.30a |  10.00ab |

\*Means having the same letter(s) are not significantly different at 5% according to Duncan’s New Multiple Range Test.

**Key:**

0mLFP/15Lwater: 0ml of Foliar Plus in 15 litres of water (control)

120mLFP/15Lwater: 120ml of Foliar Plus in 15 litres of water

140mLFP/15Lwater: 140ml of Foliar Plus in 15 litres of water

160mLFP/15Lwater: 160ml of Foliar Plus in 15 litres of water

***Effect of Foliar Plus on the Leaf Area Index (LAI) at 4WAP (1st harvest) and 6WAP (2nd harvest)***

At the 1st LAI, 0.65, 0.54, 0.63 and 0.58 were statistically (p≥0.05) the same as produced by different levels of the treatment (0ml, 120ml, 140ml and 160ml) each in 15L of water. The treatment, 0mlFP/15Lwater produced the highest value (0.65) whereas 120mlFP/15Lwater produced the lowest value (0.54).

Again, at 6WAP, the control gave the greatest LAI value (0.62) as 120mlFP/15Lwater recorded the lowest (0.45). However, there were statistical (p≥0.05) similarities among the treatment means, including 0.49 and 0.50 obtained from 140mlFP/15L water and 160mlFP/15L water respectively (table 2)

**Table 2. Effect of Foliar Plus on the crop dry weight at 4WAP, crop dry weight at 6WAP, leaf area index (LAI) at 5WAP (1st harvest) and 6WAP (2nd harvest)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  Treatments | Crop Dry Weight  (CDW)(g)  4WAP | Crop Dry Weight  (CDW)(g) 6WAP  | Leaf Area Index (LAI) 4WAP |  Leaf Area Index (LAI) 6WAP |
| 0mlFP/15Lwater |  18.20a |  23.27a |  0.65a |  0.62a |
| 120mlFP/15Lwater |  18.03a |  34.70a |  0.54a |  0.45a |
| 140mlFP/15Lwater |  29.30a |  35.83a |  0.63a |  0.49a |
| 160mlFP/15Lwater |  28.87a |  30.83a |  0.58a |  0.50a |

\*Means having the same letter(s) are not significantly different at 5% probability according to Duncan's New Range Test.

***Effect of Foliar Plus on the Net Assimilation Rate (NAR) (g/m2/day)***

Table 3 shows that the value, 7.84g/m2/day of NAR, which was produced by 140FP/15Lwater was the highest, but statistically (p≥0.05) the same with 6.42g/m2/day, 4.17g/m2/day and 2.33g/m2/day produced by 0mlFP/15Lwater, 120mlFP/15Lwater and 160mlFP/15Lwater respectively.

***Effect of Foliar Plus on the Crop Growth Rate (CGR) of Cucumber (g/m2/day)***

There was no significant (p≥0.05) effect of Foliar Plus on the CGR of cucumber as indicated by data analysis (Table 3).

The treatment, 120mlFP/15Lwater gave the greatest value (2.38g/m2/day) of CGR, which was significantly (p≤0.05) different from 0.72g/m2/day and 0.28g/m2/day produced by 0mlFP/15Lwater and 160mlFP/15Lwater respectively, but not significantly (p≥0.05) different from 0.93g/m2/day given by 140mlFP/15Lwater (table 3).

***Effect of Foliar Plus on the Relative Growth Rate (RGR) of cucumber (g/m2/day)***

Foliar Plus effect on the RGR of cucumber was recorded on Table 3. Different levels of Foliar Plus, 0mlFP/15Lwater, 120mlFP/15Lwater and 140mlFP/15Lwater and 160mlFP/15Lwater produced 0.154g/m2/day (highest value), 0.039g/m2/day, 0.013g/m2/day and 0.003g/m2/day (lowest value), indicating statistical similarities among themselves. Though 0mlFP/15Lwater got the highest value (0.154) but not significantly (p≥0.05) different from the rest (Table 3).

**Table 3. Effect of foliar plus on the net assimilation rate (NAI), crop growth rate (CGR) and relative growth rate (RGR) of Cucumber**

|  |  |  |  |
| --- | --- | --- | --- |
|  Treatments | Net Assimilation Rate  (NAI) (g/m2/day) | Crop Growth Rate (CGR)  (g/m2/day) | Relative Growth Rate (RGR) (g/m2/day) |
| 0mlFP/15Lwater |  6.42a |  0.72b |  0.154a |
| 120mlFP/15Lwater |  4.17a |  2.38a |  0.039a |
| 140mlFP/15Lwater |  7.84a |  0.93ab |  0.013a |
| 160mlFP/15Lwater |  2.33a |  0.28b |  0.003a |

\*Means having the same letter(s) are not significantly different a 5% probability according to Duncan's New Range Test.

***Effect of Foliar Plus on the Leaf Area Ratio (LAR) of cucumber (cm2/g)***

In Table 4, though the control had the highest value (23.72cm2/g) followed by 20.77cm2/g obtained from 120mlFP/15Lwater, but their values were statistically similar to 17.06cm2/g (the lowest) and 17.81cm2/g obtained by 140mlFP/15Lwater and 160mlFP/15Lwater respectively.

***Effect of Foliar Plus on the Specific Leaf Weight (SLW) of cucumber (g/cm2)***

In Table 4, Foliar Plus did not have a significant (p≥0.05) effect on SLW as revealed by data analysis. The values, 0.02g/cm2 produced by 140mlFP/15Lwater was significantly different from and greater than 0.013g/cm2 given by 0mlFP/15Lwater, but not significantly (p≥0.05) different from 0.018g/cm2 and 0.019cm2 obtained from 120mlFP/15Lwater and 160mlFP/15Lwater respectively.

***Effect of Foliar Plus on Leaf Weight Ratio (LWR) of cucumber (g/g)***

In Table 4, the effects of Foliar Plus on the leaf Weight Ratio (LWR) were recorded. The treatment 140mFP/15Lwater gave the greatest value (0.328g/g) though not significantly different (p≥0.05) from other values like 0.294g/g, 0.314g/g and 0.322g/g which were produced by 0mlFP/15Lwater, 120mlFP/15Lwater, and 160mlFP/15Lwater respectively (Table 4).

***Effect of Foliar Plus on Specific leaf Area (SLA) of cucumber (m2/g)***

In terms SLA, Table 4 shows that 105.10m2/g (the highest value) recorded for 0mlFP/15Lwater, exhibited no significant (p≥0.05) difference from 71.43m2/g, 52.44m2/g (the lowest value) and 54.99m2/g gotten from 120mlFP/15Lwater, 140mlFP/15Lwater and 160mlFP/15Lwater respectively. In general, there were statistical (p≥0.05) similarities among the treatment means (Table 4).

**Table 4. Effect of foliar plus on leaf area ratio (LAR), specific leaf weight (SLW), leaf weight ratio (LWR) and specific leaf area (SLA) of cucumber**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Treatments | Leaf-Area Ratio(LAR) (cm2/g) | Specific-Leaf Weight(SLW) (g/cm2) | Leaf-Weight Ratio(LWR) (g/g) | Specific-leaf Area(SLA) (m2/g) |
| 0mlFP/15Lwater |  23.72a |  0.013b |  0.294a |  105.10a |
| 120mlFP/15Lwater |  20.77a |  0.018ab |  0.314a |  71.43a |
| 140mlFP/15Lwater |  17.06a |  0.020a |  0.328a |  52.44a |
| 160mlFP/15Lwater |  17.81a |  0.019ab |  0.322a |  54.99a |

\*Means having the same letter(s) are not significantly different 5% probability according to Duncan's New Range Test.

**Discussion**

Treatment of Foliar Plus had a significant effect on both days to 50% flowering and 50% maturity. Here, the control plots took the greatest number of days to flowering and maturity, whereas the treatment 120 mlFP/15Water had the least number of days, probably suggesting being the most suitable for cucumber production. But other higher concentrations of Foliar Plus (i.e. 140mlFP/15Lwater and 160mlFP/15Lwater) slightly increased days to flowering and maturity instead of further reduction. The reason for this result might be due to higher doses of Foliar Plus not being favourable for cucumber plant through slowing down its growth and development, which resulted in taking more days to mature than plants treated with lower doses, even though plants that received higher doses of FP still took lower days than the control plots. This is in agreement with Pal *et al.* (2016) who reported that the minimum number of days to fruit initiation, fruit maturation and harvest were recorded in cucumber plants sprayed with Gebberelic and Potassium whereas maximum values were recorded in the control. Similarly, in agreement, Khan *et al.* (2009) also reported that application of foliar fertilizer (from seaweed extract) on maize plant was able to trigger early flowering and fruit set in a number of plants. It could be attributed to an increase in net photosynthesis, transpiration rate and intracellular concentration of CO2 as Anjum *et al.* (2011) observed such in the maize plant.

Analysis revealed that canopy cover (CC), crop dry weight (CDW), leaf area index (LAI), net assimilation rate (NAR) and leaf area ratio (LAR) of cucumber were not significantly affected by the Foliar Plus treatment. This result disagreed with Mohnoodi *et al*. (2020) who observed that foliar application of nutrients significantly affected physiological traits like leaf area index, total crop dry weight of plant, etc. Though the effect of Foliar Plus was not significantly different among the treatment means in terms of CC and CDW, but all the treated plots obtained values slightly higher than the control. This appears to agree with Kowsar and Boswal (2015) who observed that bio-fertilizer and other liquid organic fertilizers sprayed on bread wheat plant (*Triticum aestivum L.)* induced various physiological characters like canopy cover, temperature depression, etc.

However, this trend seems to be in contrast with values recorded over RGR where there was a fairly gradual decline in values from the control (0mlFP/15Lwater) to the highest concentration (160mlFP/15Lwater) of FP. This phenomenon could be as a result of an attendant increase in toxic level of FP in addition to adverse environment, resulting in low leaf stomatal gas exchange and diminished chlorophyll content, which hamper photosynthetic efficiency and general performance of the plant leading to low values recorded. This conforms to Diaz-Leguizamon *et al.* (2016) who reported that Luloplant treated with bio-stimulant resulted in lower gas exchange such as photosynthesis, stomata conductance and plant transpiration including leaf chlorophyll content.

Meanwhile, in terms of crop growth rate (CGR) and relative growth rate (RGR), Foliar Plus had significant influence only on the crop growth rate (but not RGR) of cucumber, as 120mlFP/15Lwater concentration got significantly the highest growth rate, followed by 140mlFP/15Lwater, 0mlFP/15Lwater and then 160mlFP/15Lwater. This apparently implies that as the concentration of FP increased, the growth rate decreased, which is suggestive of possible toxicity by the higher concentration of Foliar Plus. In this regard, Wojcik (2004) has stated that foliar fertilizer can hinder plant development through scorching or burning effect if the concentration is too high. However, the result agrees with Mondal *et al.* (2016) who observed that foliar application of Chitosan in tomato at 50mg/L and 75mg/L gave the highest values, whereas 100mg/L, 25mg/L and 0mg/L of the same fertilizer gave lower values. Saied *et al.* (2018) reported similar results, conforming to the result on crop growth rate (CGR) of mustard seed when GABA (Gamma-aminobutyric acid) was applied on it. But in contrast, Kumar *et al.* (2017) discovered that the highest crop growth rate in rice resulted from foliar application of nutrients at the stages of tillering and panicle initiation in addition to milky stage. These divergent results are in accordance with Fernández and Eichert (2009) who stated that foliar application also depends on biological characteristics involving specific botanical species and varieties, structure, size, morphology of leaves, nutrient balance of plants and phase of development.

Analysis showed that Foliar Plus had no significant effect on leaf weight ratio (LWR) of cucumber and specific leaf area (SLA) of cucumber, except specific leaf weight (SLW) where all three treatment concentrations (120ml, 140ml and 160ml) of Foliar Plus gave the higher values more than the control (0ml) which had the least value, significantly different from that given by 140ml. Probably, it was due to the fact that plants that received the treatments absorbed more nutrients like Nitrogen leading to higher biological/physiological activities such as higher stimulation of root nutrient absorption and photosynthetic efficiency resulting in more vegetative expansion, and accumulation and storage of metabolites (Kannan, 2010), and this could be responsible for recorded slight increase in SLW and LWR.

In the case of specific leaf area (SLA), the control (0ml or 0mlFP/15Lwater) gave the greatest SLA, though not significantly different from other values obtained in plots that received higher concentrations. There was a fairly steady decrease in SLA values as the concentrations increased, appearing to agree with Panayota (2004) who noted that increasing doses of Hortigrow on pepper decreased the vegetative growth. However, this result is not in conformity with Adesida *et al.* (2020) who reported that liquid poultry manure (organic fertilizer) sprayed on cucumber did not affect leaf number and leaf area. Again, Panyaribuan *et al.* (2019) revealed that leaf area of sweet corn was increased correspondingly to a certain point with increase in the doses of foliar organic fertilizer up to 75ml/L, above which there was no noticeable increase in leaf area. Notwithstanding, this outcome of the present study could be as a result of factors like fertilizer forms and concentrations that affected the result, just as Buereu *et al.* (2011) had observed in their study, because it could not have been Foliar Plus that slightly increased the SLA value in the control plot.

**Conclusion**

With liquid organic foliar feeding/application, vegetable crop productivity can be enhanced through correcting the crop physiological imbalances occasioned by soil nutrient deficiencies. The present study indicated that the liquid organic fertilizer, Foliar Plus, did impart significantly on the crop growth rate (CGR) and specific leaf weight (SLW) of cucumber as 120mlFP/15Lwater and 140mlFP/15L water gave the highest value of CGR whereas 0mlFP/15Lwater got the lowest values. However, canopy cover (CC), crop dry weight (CDW), leaf area index (LAI), Net assimilation rate (NAR) and specific leaf area (SLA) of cucumber were not significantly affected by different doses of the treatment.

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1.

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3.

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