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Yield and Yield Components of Greenhouse Cucumber as Affected by irrigation Regimes and Growth Media

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Abstract

This research was carried out in a greenhouse located at Council for Scientific and Industrial Research (CSIR) - Savanna Agricultural Research Institute (SARI), Nyankpala, Northern Region of Ghana from June to September, 2022. The study compared the yield obtainable with greenhouse cucumber grown on soil with cocopeat and soil - biochar mixture under irrigation regimes. The experiment was a 3 x 3 factorial study laid out in Randomized Complete Block Design (RCBD) with three replications. The treatments consisted of irrigation regimes (100% ETc, 75% ETc, 50% ETc) and growth media including (Soil (So), Soil plus Charred rice husk (So + CRH) and Cocopeat (CP)). Data was collected on cucumber yield and yield parameters. The result of Analysis of Variance (ANOVA) showed 100% ETc supported optimum yield of greenhouse cucumber. Flower count was highest for CP – grown plants irrigated at 100% ETc while the highest flower abortion occurred on plants grown on So + CRH at 75% ETc. Plants irrigated at 100% ETc gave the highest yield of 116.3 t/ha while those irrigated at 50% ETc gave the lowest yield of 37.8 t/ha. Yield obtained from plants irrigated at 75% ETc (70.6 t/ha) was similar to that obtained at 100% ETc; It is therefore recommended for greenhouse cucumber farmers in northern Ghana to irrigate at 75% ETc thereby saving water and optimizing yield. More work could be done on combination of CP and CRH for greenhouse cucumber production.

Keywords: Charred rice husk • Cocopeat • Flower abortion • Flower count • Soil

Introduction

Agricultural production in Ghana, particularly in the Northern part, is threatened by water scarcity and increased competition for available water resources, leading to insufficient water supply for agricultural production. Due to this limitation in availability of water, it becomes imperative to know how to irrigate timely with the least amount of water, for optimum yield, water efficiency and profit [1]. Irrigation has been suggested to play a vital role in control of food scarcity and poverty alleviation. It serves as a sure way of reducing drought impacts and improving agricultural productivity [2,3]. For example, according to Awe GO, et al. [4] drip irrigation technology has been advocated to ensure the optimal use of water and nutrients in agriculture and improving irrigation efficiency. Mao X, et al. [5] observed fruit yields of cucumber were especially highly affected by water deficiencies during fruiting stages.

Agricultural productivity is threatened by changing weather patterns, which result in climate change, increased rainfall variability and temperature fluctuations [6]. One of the adaptive strategies that can help cope with these changes is greenhouse cultivation, which helps in regulating the plant's macro and micro environment, improving yield and quality of the produce and optimizing plant growth and development [7].

Cucumber (*Cucumis sativus L.*) is an important creeping vegetable and one of the most popular members of the Cucurbitaceae family with a high global consumer demand [8]. Cultivation of cucumber under greenhouse condition gives increased productivity and higher fruit quality, resulting in better market price in addition to the all year - round production. With this, cucumber becomes one of the major lucrative vegetables cropped under greenhouse conditions [9-11].

Soil is often the most available medium for growing plants as it supplies water, nutrient, air and support which are all necessary for plant growth [12]. However, most times, it has been found that cultivating vegetables in soil under greenhouse condition gives rise to risk of soil borne diseases including woot roots, root-knot nematode and root rots amongst others that has a negative effect on cucumber production [13-15]. Also, difficulty is mostly encountered in obtaining fertile arable lands, in this case, the soilless culture comes in handy. This culture does not involve the regular fumigation which is mostly done to soils and which leaves behind side effects on crops thereby causing health problems to man [16] mentioned that, soilless cultivation has been known internationally for its ability to maintain efficient plant production. These media are also relatively light weight, readily available and more uniform than mineral soils. This study compared the yield of cucumber grown on soil to those grown on cocopeat and soil mixed with rice husk biochar at varying irrigation regimes.

Materials and Methods

Experimental site and climatic data: The experiment took place under greenhouse conditions between the period of June 2022 to September, 2022. The greenhouse is located at the Council for Scientific and Industrial Research (CSIR) - Savanna Agricultural Research Institute (SARI), close to the University for Development Studies (UDS), Nyankpala, Tolon District, Northern Region of Ghana. It is located between latitude 9.4066° N and longitude 0.9882° W, and elevation of 169m

Experimental design, treatments and replication: The experiment was a 3 x 3 factorial study laid out in Randomised Complete Block Design (RCBD) with three replications. The two sets of experimental treatments that were applied are: amount of water application and the growth media. The depth of irrigation application included: 100% crop water requirement (ETc) (I1), 75% ETc (I2) and 50% ETc (I3). The growth media included: soil (M1), soil plus charred rice husk(M2) and coco peat (M3)

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Yield and yield parameters: Data were collected on yield and yield parameters including flower count, flower abortion, number of fruits, length of fruit and weight of fruit.

Statistical analysis: Data were arranged and organized for the suitability of statistical analysis; analysis of variance (ANOVA) was performed using Genstat software 12th edition. The significant treatment means were separated using least significance difference (LSD) at 5% probability level

Results

Cucumber plant yield parameters and yield: Significant differences were noted for the interactive effects of irrigation regimes by growth media ($P<0.01$), main effect of irrigation regimes ($P<0.05$) and main effects of growth media ($P<0.01$) on flower count. Flower abortion was significantly determined by the interactive effects of irrigation regimes by growth media ($P<0.05$) and the main effects of the growth media ($P<0.05$). The average fruit number per plant, average weight of fruit per plant and average yield were significantly determined by the effects of irrigation regime at $p<0.001$, $p<0.05$ and $p<0.001$ respectively. The average fruit length was significantly affected by the interactive effects of irrigation regimes by growth media. The average fruit count gave 3.95, 3.35 and 2.45 at 100% ETc, 75% ETc and 50% ETc respectively. The average fruit weight included 342.4g, 295.5g and 281.1g at 100% ETc, 75% ETc and 50% ETc respectively. Yield at 100% ETc, 75% ETc and 50% ETc were 116.3 t/ha, 70.6 t/ha and 37.8 t/ha respectively (Table 1, Figures 1-3, Table 2, Figures 4,5 Table 3 and Figure 6).

Discussion

As deficit irrigation increased, number of flowers reduced. This is not unexpected as had confirmed that, high moisture presence promotes production of flowers in crops. This result conformed to that of Silva CJD, et al. [17] who observed that, irrigation regimes ranging from 100 – 115% gave more flowers as compared to 50% ETc. and where flower number was reduced at an irrigation regime of 55%. Highest flower abortion was recorded for cucumber plants grown on So + CRH at 75% Etc. When this irrigation regime is compared

Table 1. Interactive effects of irrigation regimes and growth media on flower count at 3 WAT.

Irrigation	Growth Media		
	So	So+CRH	CP
100% ETc	2.86	3.24	2.85
75% ETc	2.68	3.29	3.24
50% ETc	2.91	3.07	3.02
P value	<0.05	-	-
LSD (5%)	0.2851	-	-

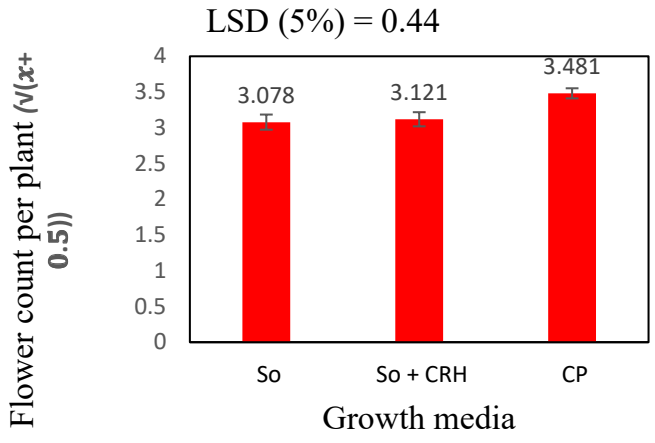

Figure 1. Main effects of growth media on flower count at 4 WAT. Bars=SEM.

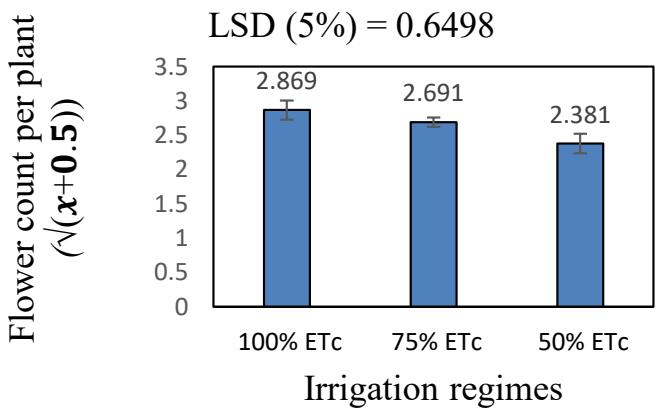

Figure 2. Main effects of irrigation regimes on flower count at 6 WAT. Bars=SEM.

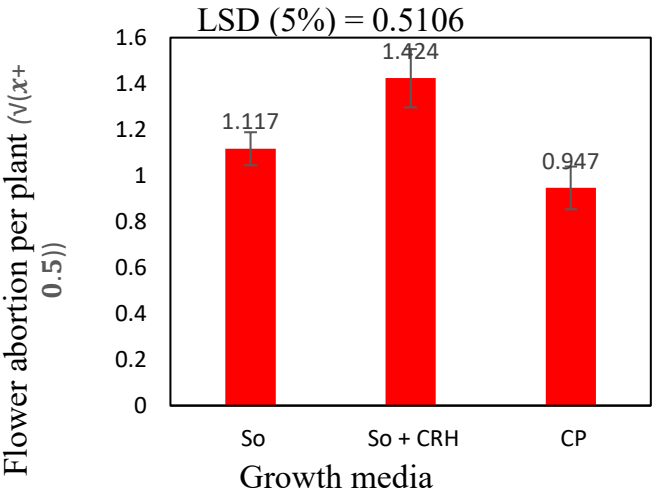

Figure 3. Main effects of growth media on flower abortion at 4 WAT. Bars=SEM.

Table 2. Interactive effects of irrigation regimes and growth media on flower abortion at 5 WAT.

Irrigation	Growth Media		
	So	So+CRH	CP
100% ETc	2.86	3.24	2.85
75% ETc	2.68	3.29	3.24
50% ETc	2.91	3.07	3.02
P value	<0.05	-	-
LSD (5%)	0.2851	-	-

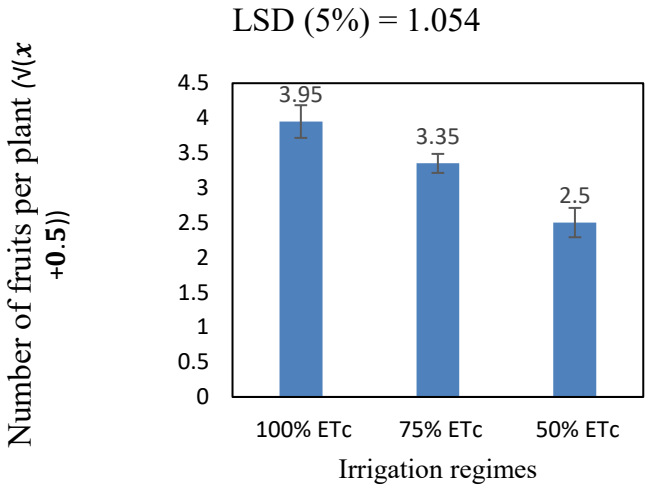

Figure 4. Effects of irrigation regimes on fruit count. Bars=SEM.

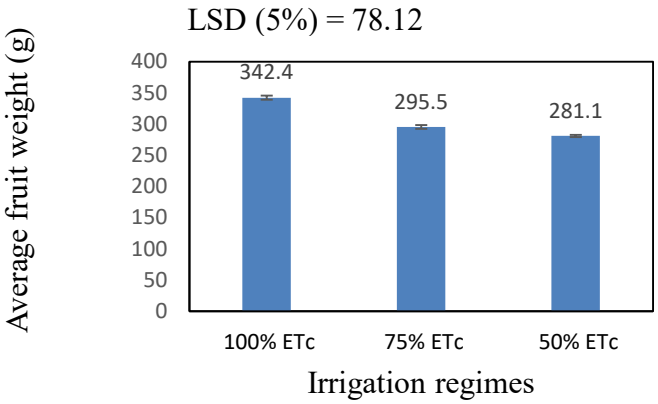

Figure 5. Effects of irrigation regimes on fruit weight. Bars=SEM.

Table 3. Interactive effects of irrigation regimes and growth media on fruit length.

Irrigation Regimes	Growth Media		
	So	So+CRH	CP
100 % ETc	22.67	20.5	25
75 % ETc	22.42	21	19.17
50 % ETc	19.17	20.67	18.67
P value	<0.05	-	-
LSD (5%)	3.18	-	-

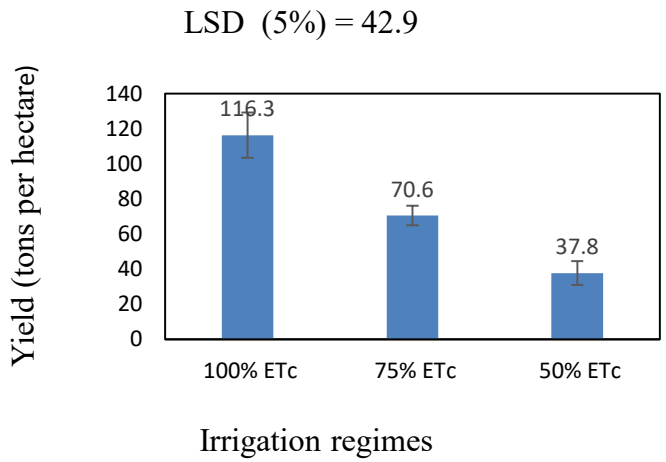

Figure 6. Effects of irrigation regimes on yield. Bars=SEM.

to 100% ETc, the result agrees with the statement of Kaya C, et al. [18] that shortage of water in plants could result in flower and fruit loss in cucumber cultivation. As compared to 50% ETc however, high flower abortion at this irrigation regime is in contrast with other researchers who quoted increase in deficit irrigation to increase rate of flower abortion Ganeva D, et al. [19] affirmed the importance of sufficient irrigation, not in excess though, to reduce susceptibility of flower loss and fruit dropping. Flower abortion is seriously affected by genotype and environmental conditions. During the period of the research, the temperature and relative relative humidity remained within the normal range required for cucumber productivity, ranging from 29.3 – 35.9°C and 54% - 73.4% respectively. The high rate of abortion in plants grown on So + CRH could however be linked to disease infestation.

The average fruit count was highest at 100% ETc and lowest at 50% ETc. This is attributable to the favorable media moisture at this regime. This result conforms to that of Sahin U, et al. [20] & Adeogun EO [21] who attributed increased fresh fruit to increased irrigation amount. Weight of the plant is a very important parameter as it represents a major portion of the yield. Cucumber fruits irrigated at 100% ETc were the heaviest followed by 75% ETc and 50% ETc. This result conforms with the research of Al H, et al. [3] and Ganeva D, et al. [19] who had highest fruit weight at 100% ETc. This contradicts other researchers including Omotade (2019) who had highest cucumber fruit weight at 80% ETc. Plants grown in CP recorded the highest average length, this could be attributed to their highly developed root systems which enables maximum exploration of the media thereby leading to higher absorption of water and nutrients, thus making them perform optimally as regards fruit length. This result is in line with Ameho CS [22] who reported highest fruit length in CP, palm fibre and CP plus palm fibre. The effect of irrigation amount on cucumber fruit yield cannot be over emphasized [23]. As the quantity of irrigation decreased, cucumber yield reduced, this could be linked to the high moisture availability as cucumber plants are known to be water – loving, most especially at the flowering and fruiting stage. This could also be associated with the increased plant height at this irrigation regime as compared to 75% and 50% ETc as tall plants are able to intercept more light for optimum photosynthesis to take place. This result agrees with other researchers who also found highly appreciable yield with 100% ETc and thus, reported increased yield of cucumber to have a linear relationship with increasing water application [24-26]. The yield at 75% ETc (70.6 t/ha) was close to what was obtained at 100% ETc (116.3 t/ha). This can be related to other researchers such as Rahil MH and Qanadillo A [27] where the highest fruit yield was determined by plant irrigated at 70% ETc followed by those at full irrigation of 100% ETc, Omotade I and Babalola I [28]. who determined highest fruit yield at 80% ETc and Hossain S, et al. [12] where highest yield was obtained at 85% Etc [29-31].

Conclusion

- CP – grown plants irrigated at 100% ETc gave the highest flower count
- Plants grown on So + CRH at 75% ETc resulted in the highest flower abortion
- Plants irrigated at 100% ETc accounted maximum yield of greenhouse grown cucumber. Yield at 100% ETc (116.3 t/ha) was similar to 75% ETc (70.6 t/ha)

Recommendations

The differences between cucumber plants irrigated at 100 and 75% ETc was not significant in relation to some of the yield and yield parameters. It is therefore recommended for cucumber growers in the greenhouse to irrigate at 75% ETc, in order to maximize yield while saving water.

- More work could be done on combination of CP and CRH for greenhouse cucumber production.
- Comparative research may be conducted in the field and greenhouse to confirm their effects in cucumber production in Ghana.

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