

INFLUÊNCIA DA PODA E DIFERENTES LÂMINAS DE IRRIGAÇÃO NA PRODUTIVIDADE DO PEPINO HÍBRIDO

KELLY NASCIMENTO LEITE¹; JEFFERSON VIEIRA JOSÉ²; GEOCLEBER GOMES DE SOUSA³, RAIMUNDO NONATO FARIAS MONTEIRO⁴; MILENA SILVA DE SOUZA⁵

¹ Centro Multidisciplinar (CMULTI), Universidade Federal do Acre (UFAC), Estrada do canela fina, s/n, Gleba Formoso, CEP: 69980-000, Cruzeiro do Sul, Acre, Brasil. kelly.leite@ufac.br. ORCID : (<https://orcid.org/0000-0003-1919-9745>)

² Centro Multidisciplinar (CMULTI), Universidade Federal do Acre (UFAC), Estrada do canela fina, s/n, Gleba Formoso, CEP: 69980-000, Cruzeiro do Sul, Acre, Brasil. jefferson.jose@ufac.br. ORCID : (<https://orcid.org/0000-0003-1384-0888>)

³ Instituto de Desenvolvimento Rural (IDR), Universidade Internacional da Lusofonia Afro-Brasileira (UNILAB), Avenida da Abolição, 03, Centro, CEP: 62790-000, Redenção, Ceará, Brasil. sousagg@unilab.edu.br. ORCID : (<http://orcid.org/0000-0002-1466-6458>)

⁴ Fundação Cearense de Meteorologia (FUNCEME), Eng.º Santana Júnior, 1005, bairro de Fátima, 60115-221, Fortaleza, Ceará, Brasil. raimundo.monteiro@funceme.br. ORCID : (<http://orcid.org/0000-0003-1136-630X>)

⁵ Centro Multidisciplinar (CMULTI), Universidade Federal do Acre (UFAC), Estrada do canela fina, s/n, Gleba Formoso, 69980-000, Cruzeiro do Sul, Acre, Brasil. milena.souza@souufac.br. ORCID : (<http://orcid.org/0000-0002-2556-9178>)

1 RESUMO

O pepino (*Cucumis sativus* L.) é uma hortaliça de expressiva importância econômica no Brasil, destacando-se pelo elevado valor nutricional e comercial. O conhecimento preciso das necessidades hídricas da cultura é essencial para o manejo racional da irrigação, visando atender à demanda hídrica das plantas, minimizar a incidência de doenças, reduzir perdas por lixiviação e evitar desperdícios de água e energia. Este trabalho teve como objetivo avaliar o efeito de diferentes lâminas de irrigação, associadas ou não à prática de poda, sobre a produtividade do pepino híbrido. O experimento foi conduzido em ambiente protegido, do tipo “guarda-chuva”, no município de Mâncio Lima - AC, entre os meses de março e junho de 2022. Utilizou-se delineamento inteiramente casualizado, em esquema de parcelas subdivididas, com cinco níveis de irrigação (60%, 80%, 100%, 120% e 140% da evapotranspiração da cultura) nas parcelas principais, e dois tratamentos de manejo (com e sem poda) nas subparcelas, com aplicação da irrigação via gotejamento. Os resultados demonstraram que a prática de poda não apresentou efeitos significativos sobre as variáveis analisadas. Em contrapartida, as lâminas de irrigação influenciaram significativamente o número de flores, peso médio dos frutos, comprimento e diâmetro médios dos frutos e a produtividade. A lâmina correspondente a 100% da necessidade hídrica (210,4 mm) proporcionou os melhores resultados na maioria das variáveis, destacando-se com uma produtividade média de 10.550,2 kg ha⁻¹.

Palavras-chave: irrigação, poda, ambiente protegido.

**LEITE, K. N.; JOSÉ, J. V.; SOUSA, G. G.; MONTEIRO, R. N. F.; SOUZA, M. S.
INFLUENCE OF PRUNING AND DIFFERENT IRRIGATION DEPTHS ON THE
PRODUCTIVITY OF HYBRID CUCUMBER**

2 ABSTRACT

Cucumber (*Cucumis sativus* L.) is a vegetable of significant economic importance in Brazil because of its high nutritional and commercial value. Accurate knowledge of crop water requirements is essential for efficient irrigation management, which aims to meet plant water demands, minimize disease incidence, reduce leaching losses, and avoid unnecessary water and energy use. This study aimed to evaluate the effects of different irrigation levels, with and without pruning, on the yield of hybrid cucumber. The experiment was conducted in a protected environment (a greenhouse structure with a “rain-shelter” design) in the municipality of Mâncio Lima, Acre, Brazil, from March to June 2019. A completely randomized design was adopted in a split-plot arrangement, with five irrigation levels (60%, 80%, 100%, 120%, and 140% of crop evapotranspiration) in the main plots and two pruning treatments (with and without pruning) in the subplots. Drip irrigation was used for water application. The results showed that pruning did not significantly affect the evaluated variables. In contrast, the irrigation level significantly affected the number of flowers, average fruit weight, average fruit length, average fruit diameter, and yield. The irrigation level corresponding to 100% of the crop’s water requirement (210.4 mm) produced the best results for most variables, achieving the highest yield of 10,550.2 kg ha⁻¹.

Keywords: irrigation, pruning, protected environment.

3 INTRODUCTION

The cucumber (*Cucumis Cucurbita sativus* L.) belongs to the Cucurbitaceae family and originates in Asia. It is a widely adapted crop to tropical climates, such as those found in Brazil, and is best cultivated in regions with high temperatures and no occurrence of frost or periods of intense cold (Goto, 2014; Carvalho *et al.*, 2013). Globally, China is responsible for approximately 60% of the global production of this crop, followed by the United States, Russia, Iran, and Turkey.

In Brazil, according to data from the Brazilian Agricultural Research Corporation (EMBRAPA), national production exceeds 200,000 tons per year, with the state of São Paulo leading the national ranking (EMBRAPA, 2020). The acquisition of agricultural products aims to meet a

fundamental human need: food. In general, this function is ensured by activities that originate in agricultural production but that depend on integration with other sectors until the product reaches the final consumer. Among the technologies applied in this process, irrigation stands out (Testezlaf, 2002).

Considered an essential practice, irrigation contributes to the stability of the supply of agricultural products and to increased productivity. However, its benefits are only realized when it is carried out efficiently, promoting the rational use of water, energy, equipment, and other inputs that make up production costs (Paiva, 2006).

Cucumber is a crop that is classified as sensitive to water stress. Under controlled conditions of irrigation deficit, a crop can accelerate the flowering process, increasing the number of fruits per plant and decreasing

its size. In cases of significant flowering deficit, fruit abortion and a considerable decrease in production can occur (Allen *et al.*, 1998). According to Orellana and Lima Filho (2004), in Amapá, the coefficients of the cucumber crop in different stages of vegetative development, flowering, fruit formation, and maturation (I, II, III, IV) are 0.40, 0.65, 0.90, and 0.70, respectively.

In addition to the water supply, crop productivity is directly related to a plant's vegetative behavior, which is responsible for the production and redistribution of photoassimilates. To achieve productive potential, it is necessary to maximize the assimilation and efficient allocation of assimilates to the fruits (Schvambach) *et al.*, 2002; Resende; Flori, 2004). The management of photoassimilate production involves mainly population control and the pruning of plants. Pruning has been widely used, especially in protected cucumber cultivation, where greater productivity is observed than in open field cultivation (Cardoso, 2007).

Pruning is indicated in protected cultivation systems; therefore, in this process, lateral shoots and fruits are removed up to the fourth or fifth internode. This creates a suitable environment for the

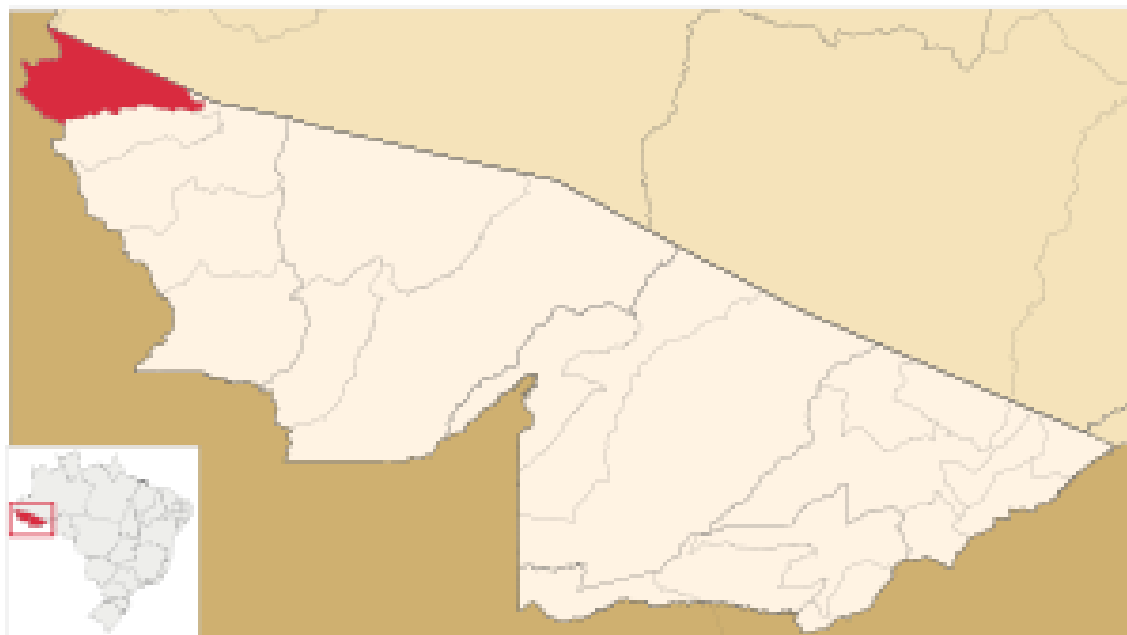
growth of three lateral branches that become productive and sprout at the height of the eighth leaf. To avoid indeterminate plant growth, some producers employ a technique called "occupation". Occupation consists of eliminating the apical bud between the 18th and 22nd internodes (Carvalho *et al.*, 2013).

In the context of plant production, pruning is considered a cultural technique capable of modifying the natural development of the plant, thus promoting, along with irrigation, increases in crop productivity (Blanco; Folegatti, 2011).

Given this context, the present study aimed to evaluate the influence of pruning and different irrigation depths on the productivity of the Aladdin F1 hybrid cucumber grown in a protected environment.

4 MATERIALS AND METHODS

The experiment was conducted in the municipality of Mâncio Lima (07°37'20"S; 72°53'32"W), Figure 1, which is located 617 km from the capital of Rio Branco, state of Acre, between the months of March and June 2022. The cultivation was carried out in a protected "umbrella" type environment in an area belonging to a local producer.

Figure 1. Location of the experimental area.

With respect to the Köppen climate classification, the region's climate is type Af (humid equatorial), characterized by high relative humidity, an average annual temperature of approximately 25°C, and an average rainfall of approximately 2,300 mm per year, with rainfall well distributed throughout the year (Alvares *et al.*, 2013).

Chemical analysis of the soil from the experimental area revealed the following values: pH = 4.8; P = 2.2 mg dm⁻³; K = 16.6 cmolc dm⁻³; Ca = 0.35 cmolc dm⁻³; Mg = 0.17 cmolc dm⁻³; Al+H = 4.47 cmolc dm⁻³; CEC (pH 7) = 6.04 cmolc dm⁻³; and V% = 9.44. These results indicate a typical tropical soil with acidic pH and low levels of Ca, Mg, P, and K, which are characteristics common in highly weathered soils.

The experimental design adopted was completely randomized, with split plots. The main plots consisted of five irrigation levels—60%, 80%, 100%, 120%, and 140% of the crop's water requirements—based on the crop coefficients proposed by Orella and Filho (2004), while the subplots consisted of two management treatments: with and without pruning. Each treatment was

repeated ten times, totaling 100 experimental units.

The plants were planted in April 2022, and the plants were harvested on June 1, 2022. The plants were grown in an “umbrella” greenhouse to avoid excessive rainfall and allow for proper control of the irrigation levels. Rain gauges were installed at the edges to quantify precipitation and verify the interference of the edge effect. The irrigation system used was a localized drip irrigation system with an operating pressure of 1.8 kgf.cm⁻², self-compensating drippers spaced 0.30 m apart, and a flow rate of 1.5 L h⁻¹, with two emitters per plant. The lateral lines had a spacing of 1.0 m, a nominal diameter of 16 mm, a PN of 250 kPa, and a length of 40 m. Each line was equipped with an individual control valve for differentiated water application.

The irrigation depth was calculated on the basis of crop evapotranspiration (ET_c), which was estimated from reference evapotranspiration (ET_o) obtained from historical data from the INMET meteorological station (INMET, 2020). The depth corresponding to 100% of the water

requirement was used as a reference for the application of the other treatments.

An Aladdin F1 cucumber hybrid was used, with a spacing of 1.0 m between rows and 0.6 m between plants, resulting in a planting density of 16,000 plants ha⁻¹. Planting fertilization was carried out with 5 kg m⁻² of bovine manure, as recommended by Filgueira (2002), in addition to the application of 80 to 100 kg ha⁻¹ of nitrogen, with adjustments based on soil analysis. Topdressing fertilization was carried out according to the crop's nutrient absorption rate to address nutritional deficiencies but without directly interfering with yield as an experimental variable.

The variables evaluated were total productivity (Yt), commercial productivity (Yc), number of fruits per plant (Nfp), average fruit length (Cmf), and average fruit diameter (Df). Fruits were harvested from ten plants per treatment and weighed on an analytical balance with 1 mg precision. Productivity per hectare was estimated on the basis of fresh mass data.

For classification as a marketable fruit, only fruits with a dark green color, a

length of 20 cm, a diameter of 5.5 cm, and an average weight of 200 g were considered. Length and diameter measurements were taken using a digital caliper.

The data were subjected to homoscedasticity analysis to verify normality. Analysis of variance (ANOVA) was subsequently performed using the F test at the 5% probability level ($p < 0.05$). When significant differences were identified, the means were compared by regression analysis, using models with biological significance and the best coefficients of determination (R^2). In cases of significant interaction between factors, one factor within another was analyzed.

5 RESULTS AND DISCUSSION

The average climate data for temperature (°C), precipitation (mm), and reference evapotranspiration (mm) during the experimental period are presented in Table 1.

Table 1. Climatological data for the experimental period.

Month	Days	Average temperature (°C)	Price (mm)	ETo (mm)
April	18	26	140	80.5
May	31	25	94	130.9
June	8	27	17	34.4
TOTAL	57	26	251	245.8

Source: INMET (2022)

Although total precipitation was similar to evapotranspiration losses, rainfall was concentrated in the first 18 days after planting, indicating a water deficit in subsequent periods in nonirrigated crops. Notably, rainfall did not influence the treatments in the experiment, since it was conducted in a protected environment.

Cucumber cultivation thrives under the influence of high temperatures, with an optimal germination temperature between

25 and 30°C. During the initial growth phase and the vegetative phase, the ideal temperature range is between 27 and 30°C, after which it decreases. For flowering and fruiting, the recommended temperatures are 27 to 28°C during the day and 18 to 19°C at night. Thus, the thermal conditions of the study region provided the optimal temperature required by the crop (Santi *et al.*, 2013).

Table 2 presents the analysis of variance (ANOVA) values for the following variables: number of flowers (NRF), average

fruit weight (PM, g), average fruit length (CMF, cm), average fruit diameter (DMF, cm), and productivity (PROD, kg ha⁻¹).

Table 2. Analysis of Variance (ANOVA) for the variables: Number of Flowers (NRF), Average Fruit Weight (PM), Average Fruit Length (CMF), Average Fruit Diameter (DMF), and Productivity (PROD).

Causes of Variation	NF	PMF	CMF	DMF	PROD.
Pruning	0.1101 ^{ns}	0.0071 [*]	0.0007 [*]	0.0224 [*]	0.6604 ^{ns}
Blade	0.0000 [*]	0.1707 ^{ns}	0.1642 ^{ns}	0.008 [*]	0.0006 [*]
Pruning vs. Blade	0.1711 ^{ns}	0.2646 ^{ns}	0.6778 ^{ns}	0.6924 ^{ns}	0.5004 ^{ns}
Overall Average	3.43	363.2	18.38	5.23	8262.91
CV	48.78	12.21	11.81	9.70	45.60
DMS Pruning	0.66	17.62	0.86	0.20	1497.16
DMS Blade	1.47	39.05	1.91	0.45	3317.99
DMS Blade X Pruning	2.08	55.23	2.7	0.63	4692.35

Source: Author's own work (2022)

* Significant at the 5% level

^{ns} Not significant at the 5% level.

The variables average fruit weight (PMF), average fruit length (CMF), and average fruit diameter (DMF) were significantly influenced by the pruning factor, whereas the irrigation depth influenced only the number of flowers (NF), average fruit diameter (DMF), and productivity (PROD). The integration of the

factors did not influence the cucumber production variables.

The irrigation depth corresponding to 131.5 mm resulted in the greatest average fruit diameter (5.7 cm), followed by the depth of 157.8 mm, whose response was statistically similar to that at the other depths evaluated (Table 3).

Table 3. Tukey's test was used to determine the average diameter of the fruits.

	mm	With Pruning	No Pruning	Averages
L1	131.5	5.9 Ab	5.5 Aa	5.7
L2	157.8	5.5 Aab	5.1 Aa	5.3
L3	210.4	5.2 Aa	5.2 Aa	5.2
L4	236.7	5.1 Aa	4.9 Aa	5.0
L5	315.6	5.1 Aa	5.5 Aa	5.3
	Averages	5.4	5.2	

*Lowercase letters a - b - Means followed by the same lowercase letter do not differ significantly.

Similar behavior was observed by Lima *et al.* (2012), who reported increasing fruit diameter in the Konan R pepper cultivar in response to increased soil water replenishment fractions. The smallest average fruit diameter estimated by these authors was 6.25 cm, corresponding to 50% of the crop-corrected evapotranspiration

(CEA), whereas the largest diameter recorded was 6.83 cm, with 125% CCE replenishment, representing the minimum and maximum water depths evaluated, respectively.

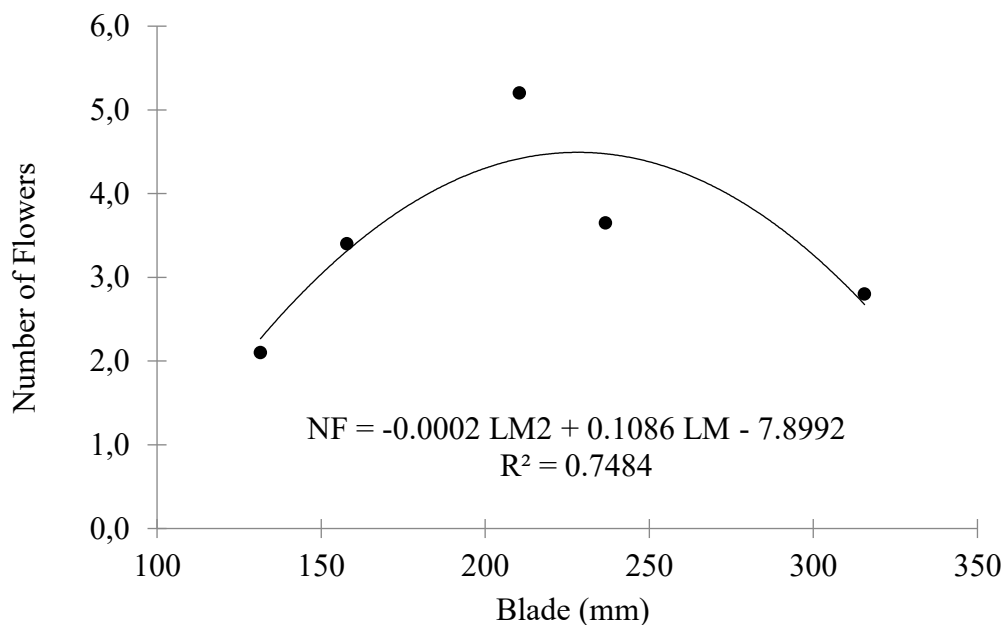
The mean comparison test demonstrated that the number of flowers, as well as the average fruit diameter, was not

influenced by pruning; however, both responded significantly to treatments with different irrigation depths.

The degree of irrigation depth had a quadratic polynomial effect, with a negative correlation with the number of cucumber flowers. The decrease in the number of flowers as the irrigation depth increased is shown in Figure 1. Crop productivity depends on an adequate water supply throughout different phenological stages; however, certain crops must be subjected to

periods of water stress during specific phases of the production cycle (Xu. *et al.*, 2024). The results obtained in this work highlight the fact that flowering is encouraged when a plant undergoes a controlled water deficit. However, according to Zhang *et al.* (2023), the intensity of the stress must be considered; more severe stress can lead to weak flowering. The first derivative of the polynomial equation found in this work yielded an optimal water depth of 271.5 mm (Figure 3).

Figure 2. Number of Flowers as a Function of Irrigation Level.



Source: Author's own work (2022)

The average fruit weight (PMg) of cucumber was significantly influenced by the treatments with and without pruning and by the irrigation depth variable, with an average fruit weight of (374.6 g) obtained with treatment L3. According to Nomura, Cardoso and Rodrigues (2000), pruning with a 10% defoliation reduces total production by 1.88 fruits/plant, of which 1.46 g are marketable, or a reduction of 381 g per plant of total production, of which 264 g would be marketable fruits. Considering the spacing used (1.0 × 0.6 m), we would have 20,000

plants ha⁻¹ and a reduction of 29,200 marketable fruits.

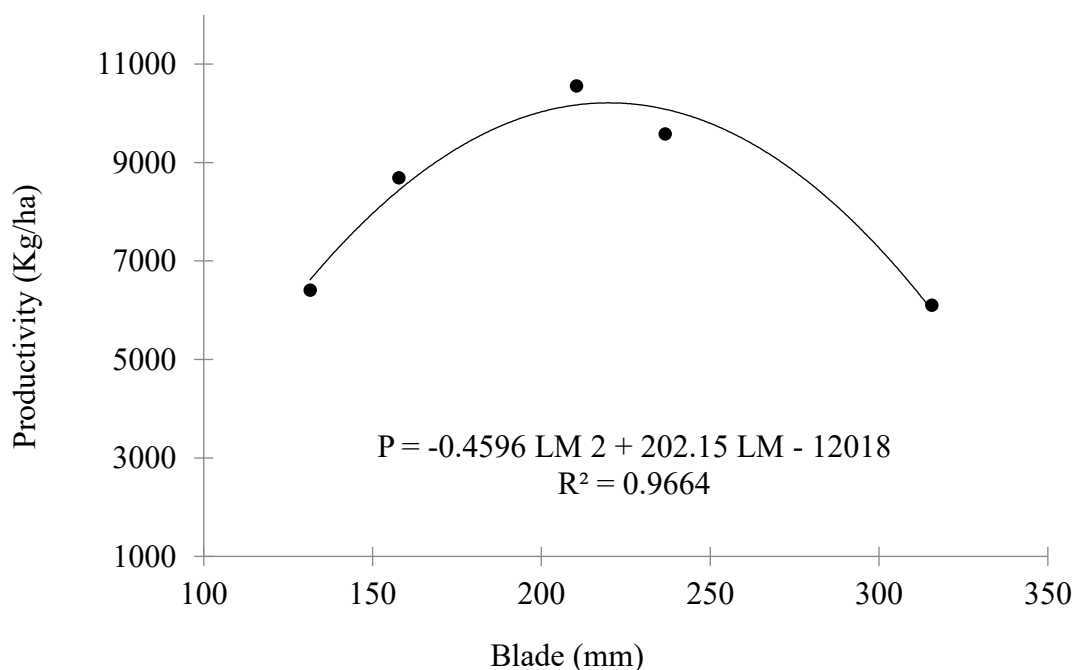
According to Silva *et al.* (2001), when the effects of different irrigation depths and frequencies on papaya productivity were evaluated, it was noted that the average fruit weight increased linearly with the applied water depth, and despite the small influence of the irrigation interval on the commercial weight of the fruits, there was a tendency for smaller fruits in the two- and five-day irrigation intervals. The rate at which the fruits gained weight was 0.043 g/mm of applied water; that is, a 42% increase in the

applied water depth provided a corresponding weight gain of 10.2%.

The influence of pruning on the variables studied was also visualized in the experiment conducted by Backes. *et al.* (2008) reported that compared with plants subjected to pruning, unpruned cucumber plants, regardless of cultivar, presented lower values for the variables analyzed. Compared with the absence of pruning, pruning above the third or fifth pair of leaves resulted in an increase of more than 280% in the number of stems per plant, approximately 70% in the number of leaves per plant, and more than 66% in the number of flowers per plant.

With respect to the productivity variable (PROD, kg ha⁻¹), it was found that irrigation depth did not influence the treatment without pruning; however, it significantly influenced the treatments with pruning. The 210.4 mm depth was significantly greater, reaching an average of 10550.2 kg ha⁻¹; however, there was no significant difference compared with the other depths. In terms of pruning, the analyzed treatments differed. Quadratic polynomial regression and correlation (R^2 0.96) demonstrate that an increase followed by a decrease in the variables can occur proportionally to the increase in the crop's water supply.

Figure 3. Productivity as a function of irrigation depth.



Source: Author's own work (2022)

These results highlight the significant influence of water depth on cucumber productivity. Similar results have been reported by different authors. Braga (2010) reported that water deficiency reduced fruit set and size, compromising productivity, whereas excess water

promoted the occurrence of diseases and nutrient leaching. According to Oliveira *et al.* (2011), when the productivity obtained with 100% water depth replacement was compared, the greatest yield reductions were generated by the 50% and 150% water depth replacement treatments. Furthermore, they

reported that there was no significant variation in fruit production between water depths with 75% and 125% replacement. However, in general, both water deficit and excess affected the number of fruits produced per Japanese cucumber plant.

6 CONCLUSION

With respect to cucumber development, the irrigation depth that performed best for most of the variables analyzed (number of flowers, average weight, productivity, and fruit length) was depth L3, corresponding to 210.4 mm.

With respect to the average fruit diameter, the irrigation depth that stood out was L1, corresponding to 131.1 mm, while the pruning variable yielded the best results.

Pruning did not significantly influence cucumber productivity but did influence the average diameter, length, and average weight of the cucumber fruit.

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