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Optimizing technological elements when growing cucumbers in non-heated green houses

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Abstract

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The experimental work was conducted in non-heated glass house Venlo type in Maritsa VCRI – Plovdiv, with green house cucumbers Defense F_1 variety, grown in three density of sowing: 1.44; 2.16 and 2.88 plant/m^2. According to the plant density, proportionally were applied three levels of nutrition with NK (100, 150 and 200%). This study aims to determine the influence of the density of the prick off, over the growth and the economic productivity in green house cucumbers. It was found that the plants grown by the four-row scheme expressed the best growth display. The most production from first class formed the cucumbers in the four-row scheme: 7499 kg/ha^{-1} in 200% nutrition, and 7071 kg/ha^{-1} in 100% nutrition. The results for the total yield were identical. The plants grown in four rows with 200% nutrition and with 100% nutrition, exceeded all other variants by total yield, respectively, 8639 kg/ha^{-1} and 8344 kg/ha^{-1}, and with lowest values were the cucumbers grown in two row scheme of growth – 4736 kg/ha^{-1}. No significant differences were reported in the values of the indexes showing the average mass of the fruits from first, second class and total yield. With highest percentage of first class yield were the cucumbers, grown by the four-row scheme with additional nutrition (87.2%), followed by the appliance of the same scheme, without increasing the nutrition (85.9%) and the lowest part of production from first class, according to the total yield formed the plants from the two-row scheme of growth – 63.3%.

Keywords: cucumbers; density of sowing; nutrition; defense F_1

Introduction

The cucumber in Bulgaria takes second place by economic importance in the green house production. The plants density is an important variable, which in the greatest extent determines the obtaining of maximum yield (Velkov & Pevicharova, 2016). An optimal growth pattern can be obtained by determining the appropriate spacing between rows. The suitable distances and plant number per unit area are a premise for more effective use of the production area. In the green house production, the cucumbers are mostly grown with density 1.4–2.5 plant/m^2, as it is defined from the region of growth and the production direction.

Optimization of the growth scheme allows effective use of the light and facilitates to decrease the competition between the separate plants, that has identical requirements. The soil content is enriched with nutrition substances, restricts the pest attacks and increases the self-shading. Nguyen (1989) found that the microclimate in means of humidity and air circulation were improved. Appropriate stocking density helps to enhance the interaction between beneficial microorganisms in the soil rhizosphere (Nnoke, 2001).

The aim of study is to determine the influence of the density of transplanting of the cucumbers over the growth expressions and the structure of the yield.

Materials and Methods

The experimental work was conducted between 2018–2021, in non-heated glasshouse Venlo type of Maritsa VCRI – Plovdiv, with green house Defense F_1 variety.

Experiment conditions

Sowing: 04–16.03.; Planting: 13–16.04.; Yielding: from 07–21.05 till 06.08.; Density of sowing: 1.44; 2.16 and 2.88 plant/m^2; Removal), of the vegetation top – up to reaching the height of the supporting wires (2 m). The experiment included five study variants (Table 1): three seeding densities (1.44; 2.16 and 2.88 plants/m^2) with proportional levels of NK fertilization (100, 150 and 200%) and was conducted using the long plot method in 3 replications.

Defense F_1 – it is distinguished with its extremely wild growth, due to which it overcome the dark periods, and the fruit giving recovers very quickly. It is resistant towards powdery mildew and cucumber mosaic virus (CVM). For all regions with strong attack from whitefly, aphids and other virus, carriers that variety guarantees permanent fruiting and high yield. It could be used as a buffer for the zones with strongest attacks. Excellent variety for the regions, where it is required more resistance towards diseases and stress. Suitable for every growth season. The fruits are with high quality 34–37 cm length. Resistances: Cca – leaves spots (high); Ccu – Scabies (high); Px – powdery mildew (average); CMV – regular cucumber mosaic (average).

The following indexes were determined:

Microclimate conditions

At 8:00 am and at 2:00 pm were registered:

– *air temperature:* It was registered with minimum – maximum thermometer;

– *the temperature of the substrate in 10 cm depth:* With soil thermometer;

– *the solar radiation:* With portable luxmeter.

Table 1. Seeding density and nutrition levels for the studied variants

No.	Density	Nutrition
1.	Two-row scheme (control)	100% nutrition K+N
2.	Three – row scheme	100% nutrition K+N
3.	Three – row scheme	150% nutrition K+N
4.	Four – row scheme	100% nutrition K+N
5.	Four – row scheme	200% nutrition K+N

*100% nutrition – recommended fertilizing in 1.44 plant/m^2;
*150% nutrition – recommended fertilizing in 2.16 plant/m^2;
*200% nutrition – recommended fertilizing in 2.88 plant/m^2

The relative air humidity was measured in the same hours.

Agrochemical analysis of the soil

The content of the assimilated nutrition elements was researched through soil analysis monthly. In water extract 1:2: pH was determined – potentiometric; total concentration of the soluble salts – by electric transmission; nitrogen – with ion-selective analyzer; phosphorus – spectrophotometric; calcium and magnesium – complexometric.

Biometric analysis

The rate of stem growth and leaf's formation were defined. The measurements were made weekly till removing the vegetative top.

Yield

Three times a week the incomings of the production and of the total yield were registered, and the data obtained were processed statistically (Duncan, 1955).

Results and Discussion

Microclimate factors

In the glasshouse, Venlo type without heating the possibilities for management, and maintenance of the microclimate are limited, due to that the last one influenced mainly from the outer climate factors, and from the type of the grown culture.

Light conditions

The average values of illumination in the green house during the morning hours for the first half of the vegetative period were lower, than the optimal light conditions. During the months with the most intensive sun shine, they closed up to the optimal requirements for the culture. The solar radiation stream reaching to the plants was limited from the beginning of May, through shadowing with whitening solution in the green house (Table 2).

Heat conditions

The average minimum temperature during the last two ten-day of April, was 9.0°C. The registered values of that microclimate index in May, were 11.4°C, in June – 15.4°C,

Table 2. Light in the green house (Lux), average for the period

	16–30 April	May	June	July	01–06 August
08.^{00}h	6937.8	13245.2	14645.3	15834.5	23200.0
14.^{00}h	23877.7	26542.2	28613.4	34217.9	38900.0

in July – 18.9°C, and in first week of August – 21.0°C. The air temperature increased in the morning hours (8:00 am) with around 5–7°C average. With advancing of the day (2:00 pm) during the particular months, it reached average values around 31.9–37.8°C. The average maximum air temperature during the reported period was in the range of 35.5 to 42.6°C, as the highest values were measured in August. Unfavorable influence over the growth and development of the plants occurs the temperature amplitude, that almost during the whole vegetation period exceeded 20–26°C, and in the period immediately after plant seedlings reached up to 27.4°C (Table 3).

Relative air humidity

During the vegetation period the air humidity was regulated through ventilation, watering and refreshing watering. Although applying those measures as a result of the higher ventilation and high temperatures, the relative air humidity decreased and was below the optimal for cucumbers (80–85%). At the beginning of the vegetation period, the air humidity at 8:00 am had average values in the range of 53.3–63.5%. During the vegetation, no great fluctuations in the percentage of air humidity were observed in the particular months. The values of that microclimate index decreased critically with the advancing of the day with 15 to 30%, and around 2:00 pm were in the range of 37.2–48.4%.

From the registered data reporting the microclimate factors, is obvious that during the period of the experimental work, the temperature amplitude and the air humidity exerted some limited effect over the optimum plant development.

Growth expressions

Average for the reported period the cucumbers grown by the four-row schemes was registered the fastest rate of growth 4.25 cm/24 h (100% nutrition), and 4.00 cm/24 h (200% nutrition). The stem of the control variant (two-row scheme) increased with slow rate, which is with proven smaller values from variant 4 (four-row scheme with 100% nutrition). It was found a one way in the obtained results for the first three years of the experimental period. The analogical tendency was observed also in the index for leaves formation rate, where the values vary from 0.42 nr. leaves/24h in the control two-row variant up to 0.53 nr. leaves /24h in the plants grown by the four-row scheme (200% nutrition). Variant 5 proven exceeded by that index the plants grown by two-row and three-row scheme. The results obtained, on the one hand, confirm the El-Shaikh' (2010) found, that as the density of cucumbers increases, the growth of the central stem increases, but data they differ in some sense regarding the formation of leaves, where the variant with the greatest density and feeding has the highest values (Table 4).

Average for the period of investigation was observed a tendency, in which the plants grown by the four-row scheme with 200% nutrition, formed the highest yield of production from first class (7499 kg/ha^{-1}) and total yield (8639 kg/ha^{-1}). In the control variant were registered the smallest quantities

Table 3. Heating conditions average for the period

	06–30 April		May		June		July		01–06 August	
Average Min. T°C	9.0		11.4		15.4		18.9		21.0	
Average Max. T°C	36.4		35.5		36.5		37.8		42.6	
	8^{00}h	14^{00}h	8^{00}h	14^{00}h	8^{00}h	14^{00}h	8^{00}h	14^{00}h	8^{00}h	14^{00}h
Average Air temperature	14.0	32.3	18.6	31.9	21.5	33.9	22.8	34.0	32.3	37.8
Average Soil temperature	16.0	23.8	18.4	24.7	21.7	23.6	23.3	16.0	23.8	27.8

Table 4. Biometric indexes of the green house cucumbers average for the period 2018–2021

Variant (growth scheme)	Stem height		Growth rate cm/24h average	Number of leaves (Nr. leaves)		Leaves formation temp nr. leaves/24h average
	min	max		min	max	
1. Two-row scheme 100% nutrition K+N	1.20	4.48	3.40 b	0.32	0.50	0.42 b
2. Three-row scheme 100% nutrition K+N	1.22	4.76	3.65 ab	0.32	0.50	0.43 b
3. Three-row scheme 150% nutrition K+N	1.90	4.88	3.83 ab	0.41	0.51	0.45 b
4. Four-row scheme 100% nutrition K+N	2.06	5.23	4.25 a	0.41	0.55	0.48 ab
5. Four-row scheme 200% nutrition K+N	1.82	5.39	4.00 ab	0.49	0.56	0.53 a

of first class production and total yield 3123 kg/ha^{-1}, and 4736 kg/ha^{-1}, respectively. In the three-row scheme without increase nutrition was reported a lowest average yield of production from second class – 791 kg/ha^{-1}, and the highest was registered in the control two-row variant 1613 kg/ha^{-1} (Table 5). The results that were obtained are confirmed by the studies of number of authors, which found that the appropriate density significantly increases the growth and the productive qualities of the cucumbers (Hana & Adams, 1991; Wanna et al., 1993; Akintoye et al., 2002; Choudhari & More, 2002; Ylimaz & Gebologlu, 2002).

On average for the period, no significant differences were observed in the average fruit mass between the first-class production and the total yield. Similarly, regarding the average fruit mass of the second-class fruits, although there were differences between the individual variants, no significant differences were found overall. During the period, the highest average fruit mass was reported as follows: for first-class fruits – 0.284 kg in the variant with a three-row scheme and 150% nutrition; for second-class fruits – 0.284 kg in the two-row scheme; and for the total yield – 0.278 kg in the four-row scheme with 200% nutrition (Figure 1). The results obtained do not fully confirm the relationship established by El-Shaikh (2010), which indicates a negative correlation between plant density and certain indicators determining fruit mass. This indicator is most likely influenced by other factors, such as microclimate and others.

Comparing the production from first class with the total yield during the period of study, it was found that in the variants with higher density is formed significantly higher part of the production from first class, in relation to the control. The average values of that index were in the range of 82.9% (three-row scheme and 150% nutrition) up to 87.2% (four-row scheme and 200% nutrition). The share of the production from first class was the smallest in two-row scheme of growth – 63.3%. The results obtained are relevant of those during the separate years, and outline a clearly expressed tendency (Figure 2).

Table 5. Distribution of the yield by quality of the green house cucumbers average for the period 2018 – 2021

Variant (growth scheme)	1^{-st} quality, kg/ha^{-1}			2^{-nd} quality, kg/ ha^{-1}			Total yield, kg/ ha^{-1}		
	min	max	average	min	max	average	min	max	average
1. Two-row 100% nutrition K+N	839	6525	3123 c	617	2802	1613 a	1456	9326	4736 c
2. Three-row 100% nutrition K+N	1724	10396	5370 b	211	1263	791 c	1935	11659	6162 b
3. Three-row 150% nutrition K+N	1514	10300	5122 b	372	2185	1361 b	1886	12485	6483 b
4. Four-row 100% nutrition K+N	3756	12213	7072 a	403	2889	1273 b	4159	15102	8344 a
5. Four-row 200% nutrition K+N	2698	14452	7499 a	110	1723	1140 b	2808	16175	8639 a

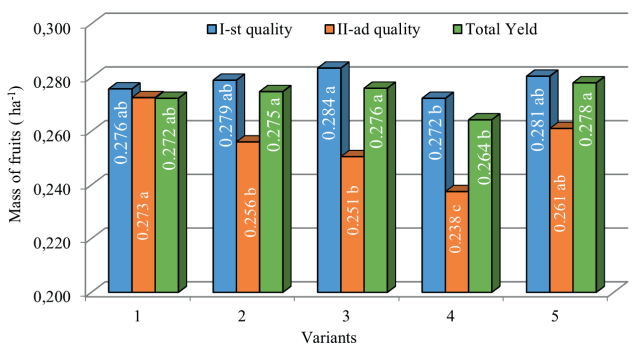

Fig. 1. Average mass of the fruits in greenhouse cucumbers, average for the period

Variants:
1. Two-row 100% nutrition; 2. Three-row 100% nutrition;
3. Three-row 150% nutrition; 4. Four-row 100% nutrition;
5. Four-row 200% nutrition

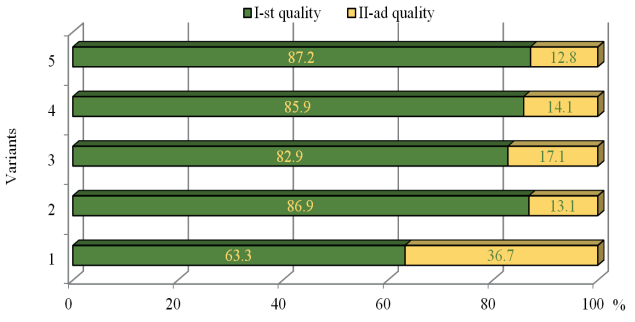

Fig. 2. Percentage distribution of the yield

Variants:
1. Two-row 100% nutrition; 2. Three-row 100% nutrition;
3. Three-row 150% nutrition; 4. Four-row 100% nutrition;
5. Four-row 200% nutrition

Conclusions

The cucumbers grown by the four-row scheme showed the best growth expressions.

The greatest production from first class formed the cucumbers with four-row scheme of growth: 7499 kg/ha^{-1} (in 200% nutrition) and 7071 kg/ha^{-1} (in 100% nutrition).

The plants grown on four-row scheme of growth with 200% nutrition and 100% nutrition, exceed all other variants according the index for total yield 8639 kg/ha^{-1} and 8344 kg/ha^{-1}, respectively, the lowest values were registered from the cucumbers grown in two-row scheme of growth – 4736 kg/ha^{-1}.

There were not reported significant differences between the average mass in the growth schemes of the fruits from first class, second class and from total yield.

The highest was the percentage from first class yield in the cucumbers, grown by four-row scheme with additional nutrition 87.2% and four-row scheme without increasing the nutrition – 85.9%, and the lowest share of production from first class in comparison to the total yield, formed the plants from the two-row scheme of growth – 63.3%.

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