FRI-9.2-1-EC-04

THE FEASABILITY OF GROWING TOMATOES IN THE CROSSING TURNOVER IN THE GREENHOUSES OF SOUTH EAST KAZAKHSTAN

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Abstract: *The article presents the results of the research on the product and the benefits of the production, greenhouse of LLP "BRB APK", in tomato department. In the winter, when light is limiting factor, was growing tomatoes under different light levels. East West Kazakhstan located in the 7-th lighted zone, what means growing tomatoes in greenhouses possible, but only with using supplementary lightning. Supplemental lightning, traditionally provided by high-pressure sodium (HPS) lamps, which is recommended for greenhouse production of vegetables during light-limiting conditions. In the research used 3type of treatment HPS, LEDs with 2 different spectrum. HPS shows good truss settles than other lamps, LED contain more sugar but less profit, LEDs good shape, good taste, sugar content. Limited light conditions are the point to research in supplementary lightning in Kazakhstan. Growing tomatoes in greenhouses with supplementary lightning is economically feasible.*

Keywords: *supplementary light, HPS lamps, tomatoes, light conditions, greenhouse.*

INTRODUCTION

In accordance with the medical standards of consumption and the Agency of the Republic of Kazakhstan on statistics, the consumption of vegetables per capita is 120 kg per year, but currently there are 71 kg per capita per year. One of the main and important tasks of vegetable growing is to provide the population with fresh vegetables all year round. It is known that in the conditions of Kazakhstan it is possible only with the combination of cultivation of vegetable crops in the open and protected ground. In recent years, the Republic is a rapid increase in the area of winter greenhouses, where it is possible to obtain off-season vegetables. Tomato is the most popular vegetable culture. Its world production is 159.23 million tons, and the area of crops - 4.73 million hectares, the share in the production of vegetables – 14 %, and in the total processing of vegetable raw materials reaches 80 %. Tomato is a valuable vegetable crop, the fruits of which contain a large amount of vitamins C, B1, B2, carotene (provitamin A), sugars, malic and citric acids, mineral salts very demanding to the light.

It is known that light largely determines the development of the assimilation apparatus, the water-heat regime, the absorption of mineral nutrients and other physiological and biochemical processes in plants. The history of plant lighted culture begins in 1865, which was divided into two periods and continued first until the 60s of the twentieth century. At the first stage (1865-1922), kerosene lamps, gas burners and small incandescent lamps were sources of artificial radiation. They allowed to study only certain physiological processes in plants in the laboratory. In the years 1922-1940, powerful incandescent lamps and some types of small gas-discharge lamps (mercury, neon, sodium) were used to irradiate plants. Lighted culture of the plants went beyond the laboratories and began to be used in production conditions. The second stage began in 1940 with the use of gas-discharge lamps. These lamps made it possible to grow plants at any time of the year in greenhouses. The light culture can increase the efficiency of other agricultural techniques, for example, low-volume cultivation technology. The combination of light culture with low-volume cultivation allows you to create a new industrial technology for growing vegetables using modern technical means. Light culture provides an opportunity to get a high yield of vegetables in a period of low light, which is very important for areas where 3-4 months per year due to a lack of natural light, it is impossible to get a crop of vegetable crops. Even where this is possible the fruit vegetable crops without additional supplementary lighting are of poor taste. According to a number of researchers, it is known that studying the effectiveness of photosynthesis in various light conditions has shown that plants effectively adapt their leaves to the colors of light in which they are grown. The yield of tomatoes is also directly dependent on the intensity of illumination. For fruit and vegetable crops, the placement of LEDs (blue diodes) in the canopy of coenosis in the presence of sodium lamps above the trellis is considered the most practical today. This hybrid combination of light sources allows you to turn off the lamp with increasing streams of natural light, while maintaining improved illumination of the active leaves of the middle tier.

So in the greenhouses of the Wageningen University tomatoes lighted up with sodium lamps (110 $\mu m/m^2$) above the culture and LEDs (85 $\mu M/m^2$) in the culture canopy. LEDs were suspended in two rows. Two types of LEDs were used: to obtain products (87 % red light, 13 % blue) and for intermediate lighting in the canopy (95 % red light and 5 % blue). At the beginning of cultivation, the plants received as much light as they could assimilate, and, as the culture developed very well, the density of the standing of the stems was increased relatively early, which led to a high load on the fruits. In the control, the yield was 79 kg/m^2 and 80 kg/m^2 with intermediate lighting with LEDs. In the latter case, they were able to save 30 % of energy to reduce the organic matter and heating and 27 % of electricity compared to control. Today it is no longer possible to present a protected ground without assimilating lighting up. The choice of type of lamps, the color of light and fittings - is huge. At present, in Kazakhstan, due to the construction of modern greenhouses and an increase in the area of greenhouses for growing vegetables by the method of low-volume hydroponics, the opportunity has arisen to grow and produce a crop of vegetables in transitional circulation in the sixth and seventh light zones of Kazakhstan, which includes south-east Kazakhstan. The use of light culture in winter greenhouses when growing, in this case, tomatoes, determines the feasibility of its cultivation, since this element (lighted culture) technology allows to get high-quality products.

EXPOSITION

To avoid deficiency of fresh vegetables during the winter, we have to grow tomatoes in Kazakhstan in crossing turnover. Crossing turnover- growing continuously during the winter, start form autumn and finish in summer. At modern commercial greenhouse five treatments were applied. The crop was planted 22 of July 2017, ended 10th July 2018. Plant density was 2,5 plant per m^2. Climate control and culture measures were all according to commercial practice. Greenhouse located in Kazakhstan, Almaty city, used variety of tomatoes - Torero F1 hybrid, big beef tomato, with average fruit weight 220-280 gramm, red color, good shape, with long shelf life, for consumption only fresh. Torero - indeterminate hybrid, not sensitive for light deficit, steady for diseases. Good variety for growing in high-tech greenhouse with artificial light. In greenhouse we keep similar climate conditions for all 5 treatments: 10000 lux; 15000 lux; LED white; LED red&blue; Control (without lighting). Growing media is rockwool. Each of treatment- department with 200 sq meter, covered by white plastic to divide treatment from each other, but with open top, to have possibility of using outside sun light. The plant density at planting 2,5 plants m^2. Additional stems were retained January 7th, result stem density 3,1 plant m^2. The CO_2 concentration was maintained about 800 ppm. Irrigation checked by Grosense program from Grodan (Fig. 1).

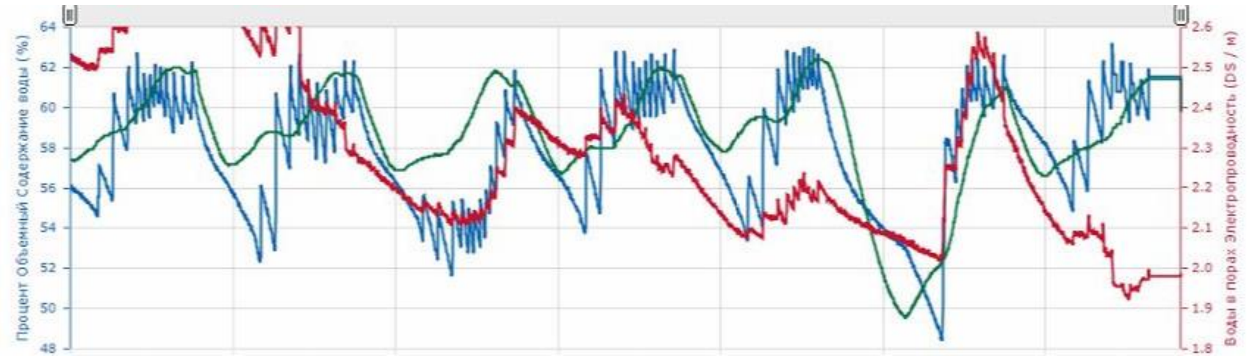

Fig.1. Water content in the slabs, %, tomato

Blue line is means irrigation starting, during the night blue line goes down, because no irrigation, in that moment water content in the slab decreasing, we can see tomato water uptake.

Climate in greenhouse is important point to manage by. Fig. 2 shows all factors grower can use to influence. Greenhouse temperature can be high with much light. With little light the greenhouse temperature is automatically maintained at a lower level. Blue line is set point, red line temperature during the day, green is outside radiation.

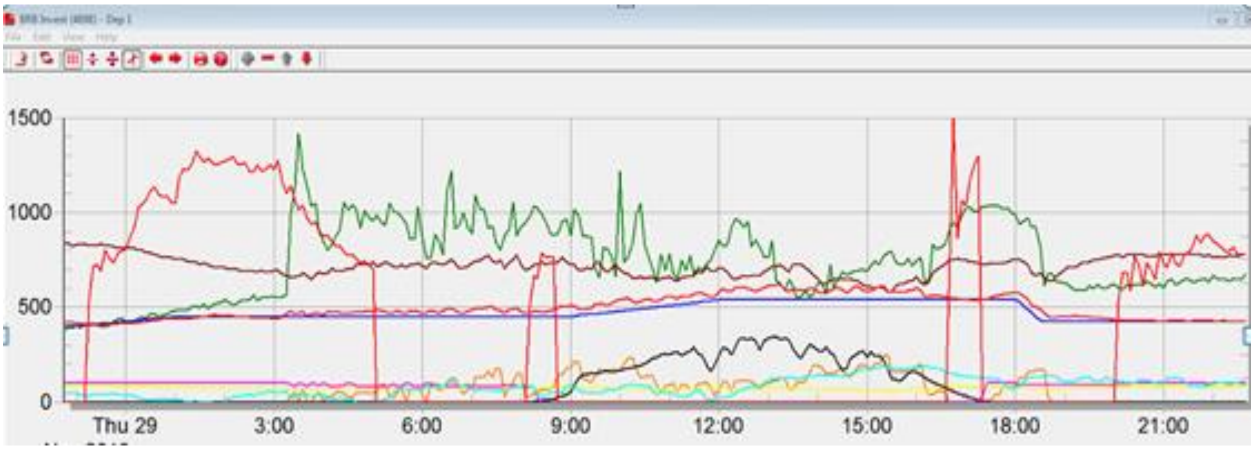

Fig.2. Actual climate graphs, one day

Table 1. Harvested tomatoes, kg/sq m, sugar content

№	Treatment	Kilo/sg. m	% of good quality	Fruit weight average	Sugar content, %	Dry matter content, %
1.	№ 1 control - no artificial light	24,3	64	70-96	3,24	3,8
2.	№ 2 15000 lux HPS	76,4	97	242-320	3,28	4,4
3.	№ 3 10000 lux HPS	58,7	92	189-234	3,24	4,2
4.	№ 4 LED white	48,3	73	157-183	3,2	4,0
5.	№ 5 LED red&blue	54,2	83	179-212	3,21	4,0

As per data in the Table 1 without artificial light have less dry matter content, but more sugar content. Because of light deficiency less fruit sizes, that gives more 2ng quality fruits (64 %). The tomato crop under HPS lighting developed more rapidly in the beginning of the experiment so that more fruits were allowed to develop per truss (less fruit pruning), resulting in a higher fruit load. HPS 15000 lux shows best results more dry matter content (4,4), more sugar (3,28). HPS 10000 lux not enough total yield per m^2, but good level of dry matter content(4,2) and sugar content (3,24).

As shown in Tab. 1 white LED not good for growing tomatoes, fruits sizes not acceptable(157-183), less sugar, dry matter content (4,0) but fruits a bit soft, not possible to transport.

Table 2. Consumption of electricity, costs

№	Treatment	electricity consumption/ kw per hour	Lighted hours	Cost of electricity, €	Total electricity per day,€
1.	№ 1 control - no artificial light	0	16	0,039	0
2.	№ 2 15000 lux HPS	1	16	0,039	0,635
3.	№ 3 10000 lux HPS	0,8	16	0,039	0,521
4.	№ 4 LED white	0,325	16	0,039	0,206
5.	№ 5 LED red&blue	0,620	16	0,039	0,394

Combined red&blue very promising, good shape of fruits, good dry matter, good taste, sugar (3,21), need to research more, may be in little combination with HPS, as a solution or inter lighting.

Table 2 shows consumption of each lamp, cost of electricity, and amount of lighted hours per day. Cost of electricity for production companies 16,68 tenge*, what equal to 0,039 euro cents. So, each lamp cost per day in the last column of Tab. 2.

Table 3. Cost of product, net profit

№	Treatment	Kilo/s g.m	Total electricity per sq. m, €	Sales price, € mean per year	Cost per sq m, €	Total profit, €
1.	№ 1 no artificial light	24,3	0	1,43	15,71	19,04
2.	№ 2 15000lux HPS	76,4	8,28	1,43	20,4	80,57
3.	№ 3 10000lux HPS	58,7	5,43	1,43	18,8	59,7
4.	№ 4 LED white	48,3	6,18	1,43	18,06	44,8
5.	№ 5 LED red&blue	54,2	11,82	1,43	18,57	47,12

Economical feasible of growing tomatoes in grossing turnover we can see in the Table 3. 1 lamp HPS to give 15000 lux cover 9,2 sq meter. Lamp HPS to give 10000 lux cover 11,5 m^2. White and red LED to produce enough light for growing tomatoes can cover 4 m^2. So electricity cost higher in the LED red&blue treatment (11,82 euro per m^2). The best results on experiment with 15000 lux 76,4 kilo per m^2, and less electricity costs (8,28 euro/m^2).

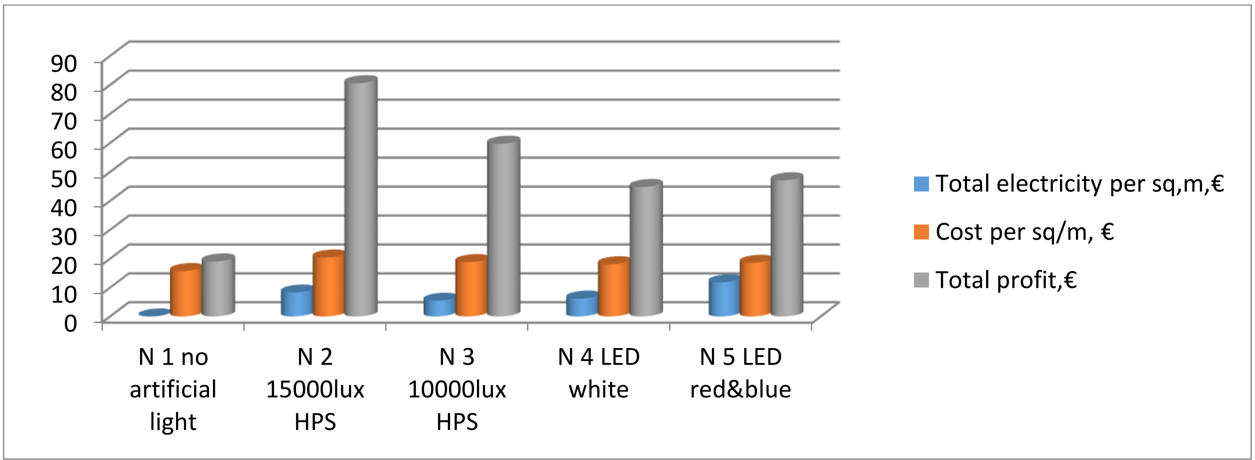

Fig.3. Profit diagram, extra costs.

There is also extra cost as seeds, labor, heating, it's depend of volume of works, for № 1 its 15,71 euro per m^2. For HPS, № 2 20,4 €/m^2, highest cost. The last column of table 3- net profit, highest profit you can find with HPS lamps (Fig. 3). The results of this experiment were influenced by the lighting systems used. The light intensity used are conform those in horticulture, thus comparison of the assimilation lighting with HPS and LED have a sound basis. However, the ratio of HPS to LED in the treatments was chosen prior to the experiment, based on current knowledge. All cultivation practices and climate set points were continuously discussed and updated by tomato growers. These growers have many years of experience with tomato production under HPS lamps while no experience with LEDs. This might have resulted in maximum yield compared to what is possible under HPS, while under LED due to lack of practical experience not yet the maximum production was attained. In this experiment less production was realized than was expected, but much has been learned. Aspects like vertical light distribution in hybrid systems and choice of light spectrum might be subjects of future research.

CONCLUSION

Economically feasible to use in greenhouse HPS lamp in comparison with other treatments. The use of LEDs can be promising for greenhouse horticulture, but before it can be put into practice on a large scale more knowledge must be acquired on effects of LED lighting on crops. Each lighting system requires its own climate set points for optimum crop growth and production. Crops under LEDs above the canopy miss radiative heat, and thus require more energy to maintain the desired greenhouse climate and crop temperature. In order to maintain a sufficiently high plant temperature in the top of the canopy under interlighting with LEDs, more light and heat is required.

Growing without artificial light in the south east of Kazakhstan not possible, not enough profit (19,04 €/m^2).

Feasible to use in South east Kazakhstan HPS lamps, profit is (80,57 €/m^2), what is 4 times more than without artificial lightning. So we would recommend to commercial growers usage of HPS lamps, while LED lamps has not enough researched in Kazakhstan.

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