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LED Grow Lights

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***Abstract.*— Lighting source based on 0.5W superluminescent light-emitting diodes. The destination of the light sources. The existing emission spectra, and the proposed one. The list of components, the modules used, the current prices on the domestic and foreign markets, the opportunities for assembling light emitters in the Republic of Moldova. The possibility of creating new jobs, reducing prices and increasing the reliability of light emitters.**

Keywords: LED, plant lighting, emission spectrum, price, economy, jobs.

I. INTRODUCTION

Plants need several conditions to grow, one of which is adequate lighting. With the help of lamps for plants, one can increase the duration of daylight hours, accelerate the growth of plants, and ensure photosynthesis. The use of artificial lighting allows you to achieve the desired result. A phytolamp is used for artificial lighting for plants, which can provide high efficiency and the necessary radiation spectrum, being universal or specialized for certain plants.

At the present time, great attention is paid to increasing the energy efficiency. Energy efficiency is one of the key aspects of any economic activity. The emergence of a new market of LED devices for lighting purposes has become possible due to the significant progress in the field of LED technologies and related technologies.

Successes in creating power sources (for LEDs) with an efficiency of 90% or more, ensuring an adequate thermal regime, producing efficient optical systems have served to create a market for LED lighting.

We aimed to create an universal spectrum, to analyze the prices of some components and modules that can be manufactured here or abroad and to adapt the concept of organizing the final assembly on the territory of the Republic of Moldova.

II. LED MANUFACTURERS

Currently, there are no manufacturers of superluminescent LEDs on the territory of the Republic of Moldova, however, these components can be easily purchased on the international market, with technical characteristics necessary for our needs at a reasonable price. In the world, there are several companies producing LEDs that account for the vast majority of the component market. Especially these companies are situated in Asia. The difference is in the technical characteristics and price [1-3]. In order to ensure the light efficiency and the necessary emission spectrum, we are obliged to use a combination of LEDs produced by world-renowned brands such as Samsung, Osram, but also low-cost LEDs produced in the People's Republic of China. In this paper, the case of assembling LED lamps based on 0.5W SMD technology is analyzed, which can offer an uniform filling of the PCB and ensure increased efficiency.

For example (white color), the LM301BEVO series LEDs can be used as white LEDs [4]:

b) Electro-optical Characteristics (I_F = 65 mA, T_j = 25°C)

Item	Unit	Rank	Bin	Min.	Typ.	Max.
Forward Voltage (V_F)	V	XA	AY	2.6	-	2.7
			AZ	2.7	-	2.8
			A1	2.8	-	2.9
Reverse Voltage (@ 5 mA)	V			0.7	-	1.2
Color Rendering Index (R_a)	-			80	-	-
Thermal Resistance (junction to solder point)	°C/W			-	7.5	-
Beam Angle	°			-	120	-

Figure 1. Electro-optical Characteristics, the opening voltage of the p-n junction

LEDs with Bin AY should be chosen, because these LEDs have the lowest opening voltage of 2.6-2.7V and therefore ensure the lowest losses at the potential barrier of the p-n junction.

We opted for CCT color temperatures of 4000K. If we analyze the electro-optical characteristics of these LEDs, it is obvious that the LEDs with a maximum luminous flux of 42 lumens must be chosen. These will ensure the maximum efficiency of the developed lamp.

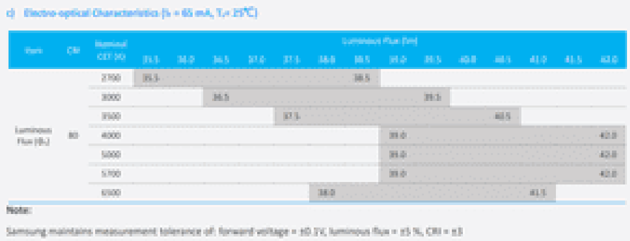
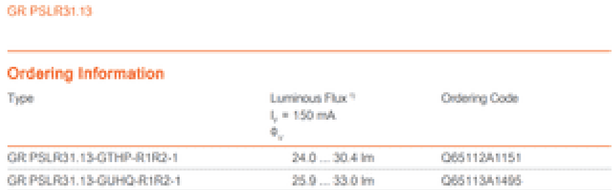


Figure 2. Electro-optical Characteristics, luminous flux for different color temperatures (CCT)

GR PSLR31.13 from Osram can be used for red color [5].



GR PSLR31.13

Ordering Information

Type	Luminous Flux I_F = 150 mA Φ_v	Ordering Code
GR PSLR31.13-GTHP-R1R2-1	24.0 ... 30.4 lm	Q65112A1151
GR PSLR31.13-GUHQ-R1R2-1	25.9 ... 33.0 lm	Q65113A1495

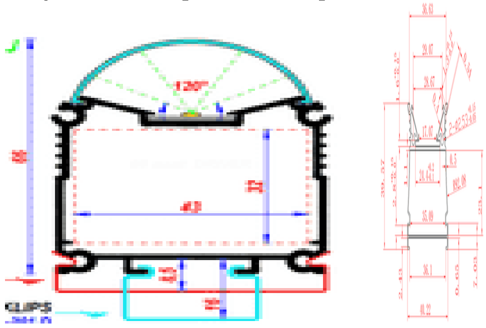
Figure 3. Osram LEDs and their luminous flux

We will give more details about these LEDs when we talk about the light spectrum of the developed lamp, and how a spectrum desired by the user can be obtained.

III. Manufacturers of parts, the complete set

The vast majority of parts manufacturers are located in China and, as a rule, they do not show much difference in quality from European or American ones (in case we are talking about LEDs), on the other hand, the price is very advantageous. Component parts can be found directly from the manufacturer (requires bulk orders ≥500 pieces) or from assembly or distribution companies.

Let's look, in particular, at the profiles for led lamps. In the figures below, three profiles will be considered, two of aluminum produced in the People's Republic of China and Turkey and one of plastic mass produced in Turkey.



a) b)

Figure 4. Aluminum profiles. Turkey (a) with a cost of $9.33 and China (b) with a cost of $8.6

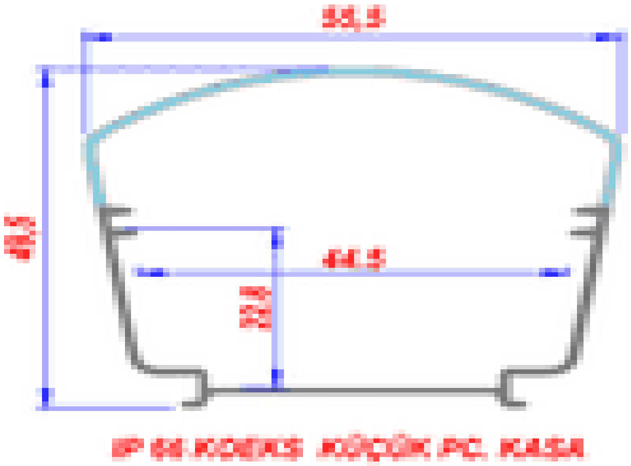


Figure 5. Plastic mass profile, Turkey at a cost of $6.62

From an economic and practical point of view, it is much better to use plastic mass profiles in ordinary greenhouses and in vertical greenhouses. They are up to 50% cheaper, provide an IP66 degree of protection and do not require grounding (to avoid electrocution).

When we talk about another component of phytolamps, the power block, a lot of manufacturers intervene. They differ according to technical characteristics and cost. We are most interested in the yield. Next, we present some manufacturers and the costs of the power supply blocks:

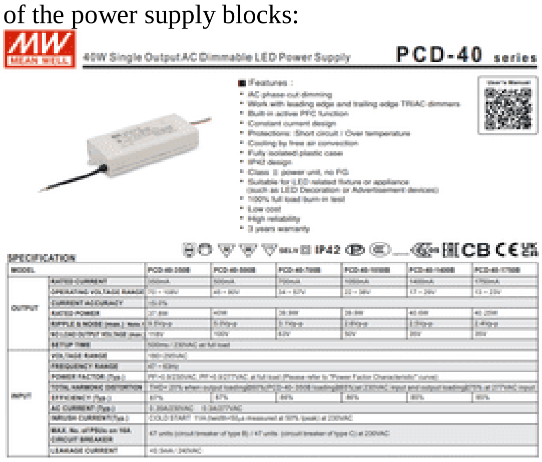


Figure 6. PCD-40-350B

This is a power supply block from the manufacturer MEAN WELL (one of the most well-known manufacturers on the world market). It has the following interesting features for us: Efficiency (Typ.) - 87%, Operating Voltage Range - 70 ~ 108V, cost up to $28.

Figure 8 shows another power supply unit CTC 39-350-110-1-П-Б IP20 001.01 This is a power supply unit from a Russian manufacturer. It has the following features: Efficiency (Typ.) > 90%, Operating Voltage Range - 60 ~ 110V, cost up to 7$.

Figure 7. Power block СТС 39-350-110-1-П-Б IP20 001.01

Power supply blocks of own production can also be used, for example a variation of the one presented in [6]. Such a power supply block can have sufficiently good performance characteristics and a lower net cost than those presented above, of only $3-4.

IV. TYPES OF LAMPS USED FOR PLANT GROWTH. THE EMISSION SPECTRUM OF PHYTOLAMPS

There are some technologies for making lamps for plants, which are classified as fluorescent, gas-discharge and LED [7].

However, the above technologies have their drawbacks. For example, fluorescent lamps for plants have been used for a long time, they have good light transmission, low cost and low heating. The disadvantage of these lamps is the influence of the light spectrum on the vision of humans and animals. Prolonged use can cause headaches.

Gas-discharge phytolamps are used exclusively in greenhouses, as they offer great heating, which provides heat and illumination. However, there is a high probability of increased humidity in the greenhouses, moisture falling on these lamps can lead to their explosion. Gas-discharge lamps have a short service life and high cost, and are considered dangerous to use.

LED bulbs for plants can be considered the best option in artificial lighting. They can be used in greenhouses, for domestic (indoor) plants, for an aquarium, for seedlings.

Until recently, only red and blue LEDs were used to illuminate plants [8]. It was believed that plants had enough of these two colors for their growth and development, and there was no need for a full spectrum of radiation. Subsequently, it became clear that this was not the case. Firstly, it is unpleasant for the working staff. Using only the red and blue parts of the spectrum adversely affects people's vision. Also, this does not fully reveal all the possibilities for the growth and development of plants.

Figure 8. Phytolamps using only red and blue spectrum

According to new research, LED grow lights can be made using only white LEDs because they contain a full spectrum including lots of blue and red light [9]. The use of only white LEDs is a compromise option, since they are technologically advanced, have high efficiency and low cost.

Figure 8. Phytolamps using white spectrum

However, the best results can be obtained using the combined use of LEDs. Phytolamps can be equipped with LEDs with a frame spectrum of luminescence, in which it is possible to achieve the development of a rhizome, a deciduous base, or the formation of fruits.

V. THE EMISSION SPECTRUM OF DEVELOPED PHYTOLAMPS AND IT'S COST

The emission spectrum is one of the most important components of phytolamps, along with efficiency and cost. Consider the existing emission spectra, how we can improve them with minimal cost.

It is important to know what photosynthesis is and how it is characterized.

Photosynthesis is the conversion of light energy into the energy of chemical bonds in organic substances with the participation of special pigments.

In total, photosynthesis reactions look like this:

$$6CO_2 + 6H_2O + Qlight \rightarrow C_6H_{12}O_6 + 6O_2$$

Special pigments are built into thylakoid membranes - several types of chlorophylls, the main of which is chlorophyll a. They are green in color because they reflect green light and absorb blue-violet and red.

Chlorophylls are organized into photosystems of types I or II, differing in preferences for light of a certain spectrum and wavelength (the optimum of the second system is shifted to a redder region and is 700 nm, the first - 680 nm) [10]. It becomes clear that we need to get a red maximum at the level of 680-700nm.

Figure 9. The spectrum of a cheap Chinese lamp

This model consumes 36W (presented in figure 9), rather low efficiency, red maximum around 645nm.

Figure 10. Intermediate model of phytolamp

The lamp which spectrum is shown in figure 10 is improved. Here we used white LEDs from Samsung [1] and colored Chinese LEDs. The consumption decreased by 3W, which is 10%, but the maximum red light is at 650nm wavelength value.

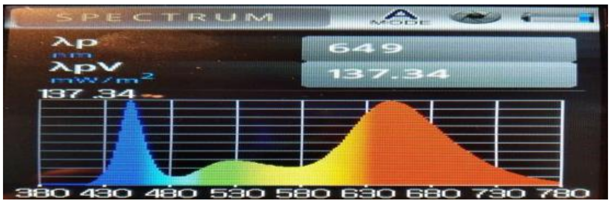


Figure 11. The spectrum of the developed phytolamp

It can be seen that this is 75% of the maximum of the red peak at 680nm. At 700nm this is about 50% of the maximum. Such results were obtained using LEDs from Osram [2]. Also, the consumption of this lamp is 28.5W, which is about 20% lower than that of the Chinese lamp. This means that using these lamps one can significantly improve the results of plant growth and development, while saving up to 20% on electricity.

LED	OR OR R R R R B B G G W W W W
OR	Osram Red, Been HP/HQ
R	China Red
B	China Blue
G	China Green
W	Samsung White 4000K

Figure 12. LEDs in one cluster

The cost of such a phytolamp produced in the Republic of Moldova is $27 without VAT.

REFERENCES

[1] https://www.samsung.com/led/lighting/mid-power-leds/5630-leds/lm561c/
[2] https://www.osram.com/ecat/DURIS%C2%AE%20S%205%20GR%20PSLR31.13/com/en/class_pim_web_catalog_103489/prd_pim_device_2402438/
[3] https://szmoonlight.com/
[4] https://cdn.samsung.com/led/file/resource/2022/04/Data_Sheet_LM301B_EVO_CRI80_Rev.2.1.pdf
[5] GR PSLR31.13_EN.pdf – Osram dataseet
[6] N. Russu, *Proiector LED 41500LM*, ICTEI, Chisinău, 24-27 Mai, 2018.
[7] https://foton.ua/faq/chto-takoe-lampy-fmtolampy.html
[8] https://master-houses.ru/svetodiodnoe-osveshhenie-dlya-rastenij-01/
[9] https://habr.com/ru/post/406663/
[10] https://indicator.ru/label/fotosintez